practically valuable illumination comes from a very few, and a summation of the light received from the whole number is likely to lead to much larger values of the illumination than can ever be realized. As Mr. Wohlauer points out, therefore, a definite point of "cut-off" must be taken from which the illumination from one source becomes zero and the work is transferred to its neighbor. The avoidance of bad cross-shadows leads to similar limitation. In actual illumination of large rooms this is a very important matter, as is also the avoidance of the quasi-specular reflection from many surfaces at large angles of incidence. In such rooms also, lighted in the way Mr. Wohlauer suggests, the boundary conditions due to walls and windows cannot for a moment be forgotten. The effect of large unshaded windows and of dark sidewalls is very considerable, even when the general illumination is pretty uniform. These and other disturbing conditions make uniform illumination very hard to get, even when the requisite reflectors are available.

Probably the most difficult space to light properly is a counting room or school in which first-class illumination is demanded at each and every point. A uniform value of the illumination over the assumed working plane is by no means sufficient to meet the practical requirements of this case. The cross-shadows must be eliminated or modified in direction, and the sources must not be unpleasantly within the field of vision at any point. In a school the situation is simplified by the fact that the desks of all face the same way. In a counting room, the desks probably will be put in arbitrarily without the slightest reference to the position of the lamps, and no matter how strong and uniform the illumination on the assumed working plane may be, there will be complaints from people who insist on getting in their own shadows. Clerical work is likely to be done with a pen almost as fine as a crow-quill and with ink which does not write black, so that the illumination must be raised beyond the point suitable for most work. Another difficulty with both schools and counting rooms is the trouble that comes on at dusk when artificial lighting must help out or replace daylight. This usually implies a shift in the general direction of the light and also a radical change in its color. If the curtains can be drawn, the trouble from the second cause ceases, but it takes great adroitness to avoid that from the first. The change is often, however, progressive, the desks near the windows having good natural light long after those well within the room require some artificial light, and the tendency is to economize by leaving the curtains up. We mention these things to make it clear that the actual conditions of good lighting imply far more than the uniform distribution of an adequate amount of illumination. It is a very useful thing to get this, however, and we hope that Mr. Wohlauer's investigations will tend to improve the design of reflectors, especially for the more recent forms of illuminants. The line now available is good in so far as it goes, but as yet inadequate in variety.

A Directive System of Wireless Telegraphy.

The article by Messrs. E. Bellini and A. Tosi, on page 1203 of this issue, describes in a very clear and interesting manner some experiments on directive wireless telegraphy carried out between three coast stations of the French Government. At the first stage of wireless telegraphic development all efforts are turned to making the outgoing waves as powerful as possible and the incoming waves as readily detected as possible. In the stage of development already reached, there are too many waves coming from different sources, and the problem is rather how to detect the particular one desired and to suppress all the rest. It has been known for some time that electromagnetic waves coming from a given point on the horizon would be capable of affecting a pair of antennas in the line of arrival, while incapable of affecting a similar pair in a line perpendicular thereto, *i. e.*, a line parallel to the wave front. This plan has been utilized both with open and closed multiple antennas to locate the azimuth of a distant radiant. This method is elaborated in the article to the extent of employing a permanent structure of two closed receiving antennas in mutually perpendicular planes, acting on a movable secondary circuit, so as to swing about a pivot, and determine the azimuth of the distant radiant. The principal value of the experiments reported in the article lies in the quantitative measurements of the power emitted and received by a vertical closed antenna loop. It is shown that the electric and the magnetic intensities in the waves make a double circle dumbbell diagram or sinusoidal diagram, while the powers are as the products of these two components, or form a double elliptical dumbbell diagram. It is open to debate, however, whether the electrolytic receiver responds more to current than to power. It would appear more probable, from the investigations already published, that this receiver depends almost entirely on the power.

The Speed of Light.

There are two general methods known for determining the speed of light in free space. One is a direct optical method, such as the method of revolving mirrors. The other is an indirect electrical method, such as the method of determining the capacity of a condenser both in electrostatic and electromagnetic measure and taking the square root of the ratio. The indirect method has the advantage of working with instruments that are primarily independent of the human eye, but has the disadvantage, on the other hand, of involving certain assumptions as to the equality of the speed of light and of electromagnetic disturbances. The optical measurement which is generally regarded as the most precise was made by Newcomb and Michelson in 1882, and gave as the result 299,860 ± 30 kilometers per second in free space. The assigned probable error was only 30 in 299,860, or 1 in 10,000; but this applies to errors of observation, and unknown constant errors might have crept in to the measurements. The electrical or indirect measurements have been in course of execution for fifty years by many different physicists. The first result, obtained by Kohlrausch and Weber in 1856, was 310,800 kilometers per second. Since then the results have been nearer and nearer to 300,000 kilometers per second, sometimes a little more than this round number, and sometimes a little less. It has been hard to say whether the best numerical results was less or more than 300,000.

The last number of the *Bulletin* of the Bureau of Standards contains a long paper, by Messrs. Rosa and Dorsey, on a recent series of electrical measurements of this velocity *v*. The series appears to be the most complete and thorough yet undertaken, and involved several condensers of different forms as well as of different dimensions. The measurements were made by placing the condenser in a Wheatstone bridge, and comparing its apparent resistance against a resistance coil. If all the quantities are accurately measured at the time of balance, the only outstanding uncertainty is that of the precision of the international ohm, the absolute measure of which enters into the

result. The final result attained by Messrs. Rosa and Dorsey is 299,710 kilometers per second in free space, within an uncertainty of 1 part in 10,000, or to the same order of precision as the optical measures above referred to. We may say, therefore, that the mean of the best optical and best electric measurements, to date, for the speed of light in free space is about 299,800 kilometers per second. This number is within 60 of the optical result and within 90 of the electrical result, the optical being the larger.

It does not follow that interest should cease in the determination of the optical and electrical measurements of light speed as soon as these measurements concur to a satisfactory degree. It will always be valuable to have careful measurements of the light speed. It is quite conceivable, for example, that the electromagnetic properties of the ether may be subject to some variations either in time, or in space, or in both. In other words, we have no positive assurance that the velocity of light is absolutely the same in all parts of the universe now, or that the velocity now is the same as when the world first evolved. Perhaps it would be more wonderful if it always and everywhere remained constant, than if certain small systematic variations occurred. The solar system, as a whole, is believed by many astronomers to move in space through a distance of about a billion kilometers per annum. Consequently a series of measurements of v taken at regular intervals of time is important as forming a historical record of the properties of space traversed.

THE ROLLING OF THUNDER.

Occasionally it happens that, in a nearby thunderstorm, we see a brief vivid flash of lightning, followed very swiftly by a single, sharp peal of thunder, followed in its turn by fainter echos and reverberations of sounds reflected from earth and sky. More commonly, however, the thunder peal is not sharply defined and steadily diminishing in intensity with time. It is usually discontinuous in intensity, with sudden variations, sounding like shot rattling successively on a window pane. The echo in such cases rattles also. This acoustical phenomenon we commonly call the rolling of thunder. The phenomenon is so common that it pervades poetry, and poets who fervently invoke rolling thunder, are not supposed to be the most keen or precise observers. It has been suggested at various times that the rolling of thunder was due to reflection from discontinuous boundaries, or was an echo phenomenon. The interesting article by Mr. D. S. Carpenter, which appears on page 1211 of this number, tends to show that this is not the case; and that, on the contrary, rolling in thunder is due to the primary sounds of successive discharges or flashes. When we see a relatively prolonged lightning flash, we witness, in reality, a number of discontinuous discharges following down the same path, and the sounds of these successive explosions come to us like the rattle of a rapid-fire gun, only less rhythmically.

Many photographs of lightning flashes have been obtained, at different times, which collectively demonstrate that lightning discharges are frequently discontinuous. One such photograph, for example, appeared on page 651 of the ELECTRICAL WORLD for October, 1899. This discontinuity is quite different from oscillation. It is very doubtful whether long lightning flashes are ever oscillatory. As has been pointed out by several enquirers into the subject, it is probable that long lightning flashes have too much resistance in the long wire of heated air to permit of oscillation. Very short induced flashes are, for the same reason, bound to be oscillatory unless extra resistance becomes included somehow in the discharge path. A mile of arc discharge must have enough resistance, even on the most generous allowances of vapor conduction, to damp out the oscillations from the most ambitious lightning flash. If a rain cloud were highly conducting, like a sheet of metal, or even like the salt water ocean, we might expect a discharge to occur suddenly, vigorously, and once for all, until time had elapsed sufficient to generate a new electric quantity by agglomeration of rain drops. We know that when electrified water vapor particles coalesce into larger rain drops, the potential of their accumlated electric charges goes up very rapidly, and this is apparently sufficient to account for the production of lightning discharges on a large scale. But rain clouds are feeble conductors, and when the electric stress is relieved by discharge at one point, through a lightning flash, it takes time for the electric stresses to equilibrate in the cloud. In the course of a few thousandths or hundredths of a second a fresh quantity of electricity may accumulate partly by more local production of raindrops, but perhaps mainly by retarded conduction through the cloud body, until a new flash or discharge occurs through the same hole in the air or air-path; because the heat in the flash takes an appreciable time to disperse. If before the air-path has sealed off electrically, by cooling, a new charge has accumulated at the top end in the cloud, a new discharge will break through the still hot path. This process may be repeated many times unrhythmically. If the wind blows the hot vapor path across the observer's plane of vision, the successive discharges will form to his eye a parallel multiple lightning flash. Mr. Carpenter's article shows that such flashes must be expected to produce discontinuous changes in the thunder peal, or rolling thunder.

As suggested in the article, it is very desirable that organized observations should be directed to this subject. It would be possible to employ, under a veranda, some summer night, when a thunderstorm commences, a revolving camera, geared with a phonograph, in such a manner that multiple flashes will be identified with multiple thunder peals in a manner capable of being analyzed subsequently at leisure. By employing two or more such recording stations, operating simultaneously, so as to procure records of flash and thunder at several places, the subject might be thoroughly investigated and our present theories converted into reliable experiences. The article alludes to explosion points at discharge bifurcations. This suggests another possibility as a goal to research. Perhaps nowhere do we produce so great volume-watts, or horse-power per cubic inch, of matter (air), as in a violent lightning flash. The energy in ergs per cubic centimeter of air in the path of the discharge must be great during the continuance of the flash, and the time-rate of arrival of this energy or its suddenness must also be very great. Jointly, the power in ergs per second per cubic centimeter must be enormous. This might be expected to product effects in matter more far-reaching than the steady arc, or the vacuum tube, or the electric furnace, can reveal. We might look for something more than the mere ionization of air. As a matter of pure speculation, we might look for a rupture of the very ions themselves. In other words, it would be conceivable that matter might be created or destroyed in a big lightning flash. These explosions in the path of a lightning discharge may be very valuable phenomena to analyze in the laboratory.

Death of Lord Kelvin.

William Thomson, Lord Kelvin, died at his home in Glasgow, Scotland, Tuesday evening, Dec. 17. For some months his health had been slowly but surely failing and his friends realized that the end was approaching, which was hastened by worry through an illness of Lady Kelvin. He was born in June, 1824, at Belfast, Ireland, and was the son of Dr. James Thomson, a man of remarkable ability and a great mathematician of his day. Lord Kelvin left no heir and his title becomes extinct.

Lord Kelvin will in the history of science take place with Newton, Leibnitz, Laplace and Helmholtz, and is perhaps the last in a line of philosophers in direct descent from Aristotle. In an age of specialists, he was the greatest specialist in innumerable branches of science, but nevertheless his towering

Kelvin

intellect escaped the fetters which science in its modern development and exacting specialization imposes upon its devotees. The activities of Kelvin were so great that a mere enumeration of his more important work is only practicable. As a mathematical physicist, he was one of the founders of the science of thermodynamics and the mathematical theory of electricity, and to him more than any other is due the modern development of the ether theory. For the past half century, no great question has arisen in science to which Kelvin did not give heed, and often the world waited upon his opinion as that of a final arbiter. While his fame ages hence will rest upon his purely intellectual achievements, he was perhaps best known to the world at large for his work on the transatlantic cable and the long line of apparatus he devised for scientific and industrial purposes. It was William Thomson's studies showing the scientific practicability of submarine telegraphy that brought the project of laying a transatlantic cable to a commercial stage; and it was his invention of the mirror galvanometer and the syphon recorder that placed submarine lines on a parity with land lines with respect to practical operation.

To merely catalogue in part other inventions, we have from him besides laboratory instruments for the absolute measurement of electrical quantities, the line of instruments of laboratory accuracy for industrial use; the ship's binnacle, which in a short time replaced all other forms of the mariner's compass on the ships of the world; the types of sounding apparatus for the assistance of navigation near shore and for sounding the greater depths of the ocean; and the seismograph.

Moonlight Schedules for 1908.

By Henry W. Frund.

In presenting lamp lighting schedules for street lighting work, to be used for 1908 (being the twenty-first annual publication to the readers of Electrical World), it must be borne in mind that these schedules differ from others in vogue, particularly what is usually called "The Philadelphia Moonlight Schedule," namely, "Light one half hour after sunset and one hour before moonset. Extinguish one hour after moonrise and one hour before sunrise."

It would interest many people if they knew how wide the range of variation is, in possible lighting schedules. There are at least seven standard schedules with 152 variations. There are certainly more than that extreme number of changes on which city contracts are based, a fact often forgotten by people who quote rates from one city to apply in arguments elsewhere.

The salient feature that has made "Table No. 1" popular and extensively used is the fact that it is practically an every and all night schedule at 3000 hours per annum against all night at 4000 hours per annum. Table No. 2 excells and practically made void the Philadelphia table by giving more lighting hours before midnight and dispensing with lighting after midnight, especially on the three nights immediately before full moon; making an approximate difference of 200 hours per annum, counting the Philadelphia table at 2200 hours per annum, and No. 2 table at 2000 hours per annum.

The lighting schedules for 1908 are based on mean local time as given in the calendar for 1908, and are calculated for Latitude 40° North, being nearly that of Philadelphia, and adapted to the following cities and states: New Jersey, Delaware, Maryland, West Virginia, Pennsylvania, Kentucky, Ohio, Indiana, Illinois, Missouri, Kansas, Denver, Colo., Salt Lake City, Utah, Carson City, Nev., and Tehama, Cal.

For adjoining states north or south of above the error may be 10 minutes, to be added or reduced from time given for lighting or extinguishing by this schedule.

In towns where standard (railroad) time is used, proper deductions or addition must be made. As will be noted, the schedules are grouped on the form of a supplement for regular and more convenient reference.

Southwestern Electrical & Gas Association.

An executive meeting was called to order on Dec. 4, at the office of Secretary Stichter, Juanita Building, Dallas, Tex., with President H. T. Edgar in the chair; the following members were in attendance: Messrs H. T. Edgar, Fort Worth; W. B. Tuttle, San Antonio; J. P. Crerar, Denison; J. D. Oliger, Cleburne; J. F. Strickland, Dallas; A. E. Judge, Tyler; H. M. Moore, Austin.

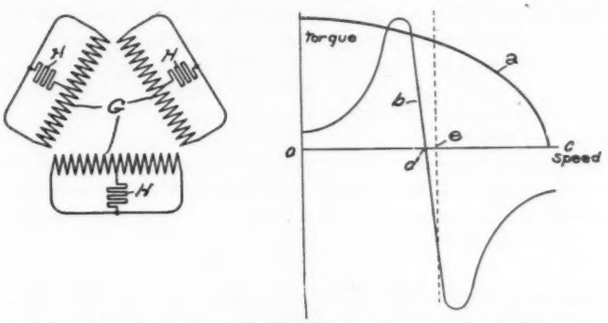
A communication was received from Mr. W. W. Freeman, secretary of the National Electric Light Association, New York City, suggesting closer co-operation between the various local organizations, which would tend to mutually benefit all concerned. The president, Mr. H. T. Edgar; the secretary, Mr. R. B. Stichter, and Mr. J. A. Myler, Jr., manager of the Dallas Gas Company, were appointed a committee of three to arrange for

all papers to be read at the next meeting, proposed to be held at El Paso, in May.

The secretary was instructed to gather such information as directed by the president of the association, regarding taxes, both ad valorem and special; cost of street improvements, donations, etc., as would be of benefit to the association, and the executive committee requested that all members of the association give the secretary every aid possible in the procuring of this information. This information is to be compiled and filed in the office of the secretary for the future use of the members of the association only.

Induction Motor with High Starting Torque.

On Dec. 3, a patent was granted to Mr. E. F. W. Alexanderson for a high-efficiency induction motor which possesses a high starting torque. There are two primary windings, one of which is arranged for twice the number of poles as the other. The secondary is arranged to offer a low-resistance path for the currents produced by the lesser number of poles and a high-resistance path for the currents produced by the greater number of poles, as indicated in Fig. 1. The motor is started by using both primary circuits simultaneously, under which conditions the rotor is subjected to the two torques shown in Fig. 2. At the speed point *d* the torque due to the



FIGS. 1 AND 2.—ROTOR WINDINGS AND TORQUE-SPEED CHARACTERISTICS.

greater number of poles is zero, while that due to the lesser number has a large positive value; at the speed point *e* the former torque assumes a negative value just equal to the positive value of the latter torque, so that the resultant torque reduces to zero. Consequently, with a certain load, the rotor would reach a speed somewhat below *e*, the particular speed depending upon the load. It will be noted that this speed is approximately synchronous speed for the greater number of poles, so that the winding giving the lesser number of poles may be open circuited and yet the speed will not be altered to any great extent, and the motor will operate as an ordinary induction motor with a short-circuited secondary.

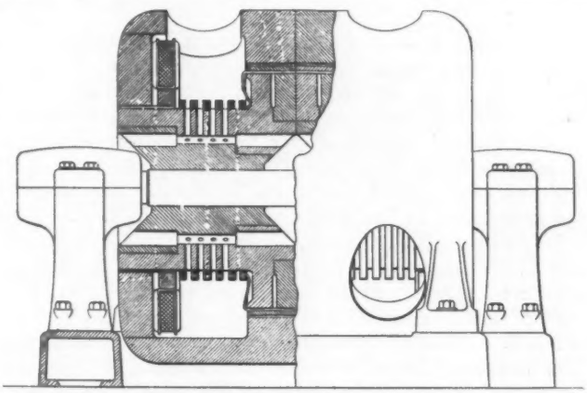
Massachusetts Institute of Technology.

At a meeting of the corporation of the Massachusetts Institute of Technology, held on Dec. 11, Acting-President Noyes presented his annual report on the progress of the past year and the larger problems of future development which the institute is facing. The membership of the faculty has been increased from 78 to 86, and the number of instructors and assistants from 121 to 124. The total registration of students is now 1410, compared with 1397 at the same time last year. The number of foreign students now forms 5.7 per cent of the whole. The three largest courses are mechanical, civil and electrical engineering, with 226, 210 and 200 students, respectively. The largest increase is in mining engineering. The average age of students entering is 18 years 11 months.

President Noyes emphasized the point that the general principles which should determine the character of the four-year course of study is a liberal education, confining the professional training to a thorough education in the principles of the fundamental sciences and in scientific methods. The aim should be, he says, to provide for specialization in the fifth year graduate course, eliminating from the fourth year curriculum the most technical branches of study. The selection of a permanent president, and the consideration of future location, new facilities and more extended summer work were also touched upon as important pending matters.

Ventilation of Unipolar Generators.

Although the armature structure of a unipolar generator revolves in a uniform magnetic field and is not subjected to eddy current and hysteresis losses and it need not be laminated, yet there are considerable losses in the conductors on the armature and at the friction surfaces of the rings, and hence the rotor must be well ventilated. The accompanying illustration shows a form of rotor construction proposed by Mr. J. E. Noeggerath, and covered by a patent issued Dec. 10. The rotor body is composed of superposed cylindrical members shaped so as to form an air chamber within the body of the rotor and provided with passages extending to the surface of the rotor. With this construction free passages are afforded



NOEGGERATH UNIPOLAR GENERATOR.

for air through the body of the rotor, and, since this air is thrown outward by centrifugal force when the machine is running, thorough ventilation is obtained. Moreover, radial passages from the air chambers within the rotor body are arranged with their outer ends adjacent to the collector rings, so as to afford efficient cooling for the rings, which in operation are heated not only by the current through them but also by brush friction.

The Demands of Architecture Upon Illumination.

One of the most interesting, and probably most instructive, papers presented before the Illuminating Engineering Society was read by Mr. Bassett Jones, Jr., at the meeting of the New York Section on Dec. 12. The paper discussed at great length the relation of architectural principles to illuminating engineering practice and showed that the illuminating engineer who considers only the scientifically practical side of the profession is necessarily doomed to ultimate failure, for he will not be able to obtain the recognition that the importance of his work deserves.

After describing the nature of aesthetic as a judgment of feeling rather than of knowledge, and giving an outline of the basis on which the feeling of the beautiful is formed, the author showed how beauty is embodied in architecture, and explained the principles of architecture.

The architect's conception of the whole arrangement must include the lighting. The light that must be provided, its tone, its intensity, its quality is a feature of his mental conception, and it is this ideal illumination that the engineer must seek to approximate. The question as to the proper location and ar-

rangement of fixtures resolves itself into the question as to the way in which the design is to be seen. The proportions of the structure, its constructive lines and the points where they originate and end—these are to be brought out in relative prominence, and to do this properly the individual responsible for the lighting must be able to discern and select these features and modify his illumination accordingly. The illuminating engineer who hopes to cope with the lighting features of architectural problems must be familiar with architecture, and particularly with the use of color in decoration; for the aesthetic value of color arrangements depends on extreme nicety of contrast, and color contrast is very susceptible to variations in tone and intensity of light, particularly at the low intensities very generally desirable from an artistic standpoint.

Mr. Jones explained that his statements were intended to apply solely to the illumination of buildings erected with due attention to the architectural beauties and not to cover spaces, such as warehouses and offices, where beauty is of no importance whatsoever.

Illuminating Engineering Society Discusses Special Street Lighting at Chicago.

The Chicago Section of the Illuminating Engineering Society had an informal meeting Dec. 12 to engage in a topical discussion of the special lighting of down-town streets. A number of the principal streets in Chicago have recently organized property owners' associations for the purpose of carrying out special spectacular lighting. The meeting was held in the breakfast room of the Grand Pacific Hotel. The discussion was participated in by Messrs. F. J. Pearson, N. R. Stansel, R. W. Bingham, J. R. Cravath, W. R. Bonham, Albert Scheible, John C. D. Clark, A. L. Eustice, L. G. Shepard, R. F. Pierce and others. The discussion was opened by an account of the engineering development of the Dearborn Street work to date by Mr. J. R. Cravath, consulting engineer for that association.

On Dearborn Street it was at first proposed to use ornamental posts supporting a cluster of globes with incandescent lamps, and the series tungsten lamp was recommended. Later a sentiment sprung up among the property owners in favor of the flaming arc lamp. The engineer's plans, as first drawn up, called for one flaming arc for every 50 lineal ft. of street, the posts being alternated. Later, for economical reasons, the lighting committee decided to recommend placing lamps alternately on every other street railway pole on each side of the street, making about one lamp to every 100 to 125 lineal feet of street. Even with one lamp for every 50 lineal feet of street, a height of 25 ft. was considered absolutely necessary to avoid excessive contrasts between the illumination near the post and the illumination midway between posts, while with the plan now under consideration of having one lamp for every 100 to 125 lineal feet of street, the contrasts in the illumination would certainly be so excessive as to produce a gloomy effect between lamps unless some scheme could be devised which would distribute the light from the flaming arc over a larger area than at present. The flaming arc, with ordinary opal globe, throws too large a proportion of its light in the vicinity of the post to produce anywhere near even street illumination. To overcome this, a method of deflecting and spreading the downward rays from the lamp had been considered, which would consist in using a hemisphere instead of a spherical globe under the arc and placing in this hemisphere a couple of conical deflectors of opal or prismatic glass, which would intercept some of the downward rays and reflect them in a direction nearer to the horizontal. Recently a simpler plan has been proposed of using a special double Holophane hemisphere for changing the distribution of light. This double hemisphere, as proposed, would have the diffusing and reflecting prisms between the inner and outer hemispheres and the two hemispheres would be sealed together dust-tight, so that the lamp trimmer would have only a smooth inner and outer surface to keep clean. It had not, however, been determined definitely whether this plan would be feasible, and whether it would be used. It was felt that unless some such plan for widening the distribution of the light from the flaming arc could be adopted, the results with lamps so far apart and only 25 ft. high would be disappointing.

Mr. F. J. Pearson said that he had made some calculations on a similar street lighting proposition for a board of park commissioners and had independently arrived at the same conclusions as Mr. Cravath; namely, that to get good results, the flaming arc lamps should be placed about 50 ft. apart and 28 ft. to 30 ft. high, with poles alternated from one side of the street to the other. He believed it would be a mistake to place them as far apart as now proposed on Dearborn Street. It is also important to keep these lamps high, so as not to interfere with show-window displays.

Mr. R. W. Bingham described briefly a new inverted gas mantle burner which is to be tried for special street and boulevard lighting, the idea being to place a cluster of these on a post.

Mr. R. F. Pierce suggested that on streets lined with high buildings, such as those in the down-town district of Chicago, it is desirable to have an illumination which will bring out the impressive height of the buildings. He suggested that in order to secure the necessary height of lamps to give good distribution from the flaming arcs, they should be hung on short brackets from the buildings themselves. It was suggested by some of the speakers that the best way to determine some of these points is to make trial installations. Alderman Francis W. Taylor, chairman of the Dearborn Street lighting committee, at the close of the discussion, however, expressed himself as opposed to anything not a uniform system for lighting the down-town streets of Chicago. He thought that illuminating engineering was an exact enough science so that engineers should be able to fix upon the best system, and that then the various improvement associations should all adopt the same plan. This seems to be the idea of the various associations at the present time, as the other associations are waiting to see what Dearborn Street adopts.

December Meeting of the A. I. E. E.

At the meeting of the American Institute of Electrical Engineers, held on Dec. 3, there were presented three papers dealing with the generation and utilization of steam.

A paper by Mr. Walter S. Finlay discussed the ratio of heating surface to grate surface as a factor in power-plant design. The author stated that the above ratio has been given a fixed value based on the production of the maximum useful effect. It seems that there has been hitherto an undue subordination of total plant costs to maximum efficiency in heat transformation.

Lately, the opinion has been advanced that considerable increase in output can, without great sacrifice in economy, be obtained by proportional increase in the grate area. This idea is based upon the possibility that combustion and heat distribution and transfer could be much improved under the new conditions, when in increasing the grate area careful attention is given to details of design most conducive to these features. Other conditions being favorable, and with a belief in the correctness of this theory, a second stoker was added to each of the 18 boiler furnaces in the Fifty-ninth Street plant of the Interborough Rapid Transit Company, in New York. Such a design gave the possibility of operating within the range of the original single-stoker boiler together with the higher range of the double stoker.

The second stoker, which was installed below the mud-drum, has an area of about 80 per cent of that of the original stoker. The lower stoker is constructed practically within a so-called "Dutch oven." The two stokers can be operated with only a little more complication than existed in the single type. Tests showed that the double-stoker operation covers the entire range of the single-stoker operation and adds an increase of output proportionate to its larger grate surface, with only a slight loss in economy, and that an increase of 71 per cent in output was accomplished with no loss in economy.

The author showed that in the case of a plant costing $125 per kilowatt of equipment, including turbo-generators and boilers equipped with stokers, the following saving might be effected by the use of double grates: First cost, 19.6 per cent; total plant charges, from 5.64 per cent at 100-per cent load factor to 7.54 per cent at 50-per cent load factor. In the case of a $150 plant the savings would be as follows: First cost, 20.8 per cent saving; total plant charges, from 7.06 per cent at 100-per cent load factor, to 9.26 per cent at 50-per cent load factor. He concluded that the remarkable effect that the grate area and heating surface ratio, when furnace design is carefully considered, may have upon first cost and total annual costs of a plant, should certainly place this particular feature well up in the list of subjects for careful investigation and should make it a point of primary and fundamental consideration in advanced design.

A paper by Mr. Henry W. Wait described the results obtained with an exhaust-steam turbine plant at the Wisconsin Steel Company's Mill at South Chicago. The turbine uses the exhaust steam from a reversible engine which drives the blooming rolls. The steam passes first to the receiver which absorbs the shocks of steam, thence to the steam accumulator, and from there to the turbine and condenser.

The accumulator, or regenerator, is a very interesting piece of apparatus, and is virtually the same as the more recent Rateau regenerators built in Europe. It acts as a heavy flywheel, absorbing or giving up energy in accordance with the requirements. When the engine is running, the exhaust steam comes from the engine through the receiver and is delivered to a number of pipes immersed in the water in the regenerator. These pipes or ducts are perforated with a number of small holes, spraying the steam, so to speak, in through the mass of the water in the regenerator. A greater or less proportion of steam is condensed in passing through the water and gives up heat to the mass of water in the regenerator. It is usual to operate the regenerators at about atmospheric pressure. In other words, the steam coming to the regenerator will usually have a temperature of 212 deg. F. and will tend to heat the water to just that temperature. If the engine stops and the supply of exhaust steam discontinues, there is a large mass of water heated to 212 deg. F., and if there is a continuous load on the turbine, the flow of steam through the turbine to the condenser will tend to make the pressure fall off slightly in the regenerator, and 212 deg. F. will then be slightly above the boiling temperature of water at this lower pressure, so that the mass of water begins to give off steam and to act like a boiler running at approximately atmospheric pressure. If, now, the engine starts again, steam will be delivered to the accumulator at a temperature slightly above that to which the water has fallen, due to the cooling effect of the evaporation of the steam for supplying the turbine, and the mass of water will again absorb heat from the exhaust steam.

In actual practice it is more convenient to run the regenerator at a pressure of a pound or two above the atmosphere, as in this case the piping is not under vacuum so that so much care does not have to be exercised to avoid air leaks. However, in certain cases, it is desirable to run below atmospheric pressure. In this way the power of the primary engine may be augmented by letting it operate at a partial vacuum. Plants are actually running with a delivery pressure to the turbines as low as 6 lbs. below atmosphere. At the Wisconsin Steel Company's plant, during normal operation, the pressure ranges from about one to two pounds above atmosphere; when the engine is exhausting heavily it runs up to about three pounds. The lower limit of pressure, when the reducing valve opens, is about atmosphere.

The primary engine operates at an average indicated horsepower of 1010 when actually running; if the total energy in one hour were distributed evenly over the hour, the average indicated horse-power would be 820. The turbine is of the Rateau type, direct-connected to a continuous-current generator of the commutating-pole type. The condenser and air pump are of standard type.

During three months when the steel plant was running at nearly full rating, the turbine delivered an average of 188,300 kw-hours per month, or 51 per cent of the total possible kw-hours if run at its rated load the entire time. The operating expenses are at the following rates, based on the above output: Oil, waste, etc., 0.002 cents per kw-hour; attendance, 0.074 cents per kw-hour; maintenance and miscellaneous, 0.011 cents per kw-hour; total operating, 0.087 cents per kw-hour; fixed charges, 0.212 cents per kw-hour; total cost of energy, 0.299 cents per kw-hour.

The fixed charges are figured on the basis of a cost of $80 per kilowatt. Interest, depreciation, etc., are allowed for at 12 per cent. Nothing is allowed for superintendence, as no additional force is required for this item. The cost being made up so largely of fixed charges, it varies very markedly with the load-factor. In fact, if the plant is run 24 hours a day, the lubrication, attendance, and maintenance are affected to only a slight extent by the amount of load, so that they have almost the same effect as a fixed charge.

A paper by Mr. C. O. Mailloux gave a clear description of the Westover carbon-dioxide recorder, which is used for indicating the percentage of carbon-dioxide in the flue gases of a boiler plant, and thus serves as a means of preventing those losses of fuel which might be termed avoidable. A certain amount of gas of known volume is passed through a solution of caustic soda, after which its volume is again measured in percentage of the original. The diminution of volume is attributable to the loss of carbon-dioxide which has been absorbed by the caustic soda. The latest form of the device is automatic in operation, the mechanism being driven by an electric motor. Continuous separate records of the percentages of carbon-dioxide for any number of furnaces can be made by means of a single system of gas vessels, when the desired gas admission valves and electrically-driven recording devices are operated in the proper sequence.

DISCUSSION.

The discussion was opened by Dr. J. A. Holmes, of the U. S. Fuel Testing Department, Washington, D. C., who stated that during the 10 years from 1895 to 1905 there were consumed nearly three billion tons of coal in the United States. In the mining of this coal nearly 50 per cent was wasted, and of the coal which reached the furnaces not more than 5 per cent of the energy was converted into useful work. The supply of coal is limited, and hence the present generation should carefully avoid all wastes.

Prof. Chas. E. Lucke examined carefully the results reported by Mr. Findlay, and found equal boiler efficiencies for single-stoker and double-stoker operation for nearly equal rates of combustion per sq. ft. of grate area and not for equal quantities of coal burned per hour. He stated that the efficiencies of two boilers should be compared only on equal terms, such as equal flue gas composition. It is possible that the results reported by Mr. Findlay can be attributed to changes in the furnace operation, such as alteration in the rate of combustion or in the draft used.

Mr. Albert A. Cary discussed the various improvements that may be introduced into the construction and operation of furnaces and boilers. He stated that this large field has been only slightly entered. There is room for a considerable change in the present view of the ratio of grate surface to heating surface. Locomotive practice is far ahead of stationary boiler practice. While stationary boiler furnaces are burning from 15 to 30 lbs. of coal per hour per sq. ft. of grate, locomotives are burning from 50 to 100 lbs. of coal per hour per sq. ft. of grate, and while stationary boilers are evaporating from 3 to 6 lbs. of water per hour per sq. ft. of heating surface, locomotives are evaporating from 6 to 15 lbs.

Mr. J. P. Sparrow stated that the New York Edison Company, in conducting tests at high rates of combustion, had burned as much as 44 lbs. of coal per hour per sq. ft. of grate surface. The tests showed that while there is a falling off of combined efficiency at high rates of evaporation, the decrease in efficiency

is not serious, if the higher rate is maintained only at time of peak load.

Mr. J. E. Moultrop expressed the opinion that better results would have been obtained with the single-stoker arrangement if more coal had been used, and especially if the furnace had been re-designed with considerably larger grate area. This plan is the one that is being adopted by the Edison Electric Illuminating Company, of Boston; it eliminates the disadvantage of having two firemen working at opposite ends of a boiler.

Mr. W. F. Wells said that in the Sixty-sixth Street station of the Brooklyn Edison Company the grates were originally installed with a ratio of heating-to-grate area of 68 to 1, but recently the fronts on the furnaces were extended and grates enlarged, giving a ratio of 53 to 1. There was obtained an increased efficiency of 14 per cent.

Mr. W. T. Ray and Henry Kreisinger, of the U. S. Geological Survey, ventured the prediction that in 10 years there will be in successful operation boilers doing several times as much work as at present per cu. ft. of space occupied and per dollar invested, and perhaps simultaneously with a much higher efficiency of conversion from coal energy to steam energy. There seems to be no reason why boilers cannot be so designed as to yield several times as much steam per sq. ft. of heating surface as they now do, and with a considerable increase in economical operation, provided forced draft or induced draft is used. Mr. F. V. Hinshaw remarked that of all fields for improvement in generating station work, the most promising is the boiler plant. To accomplish the desired results, careful study of the furnace and boiler in action is required. The invention of practical carbon dioxide recording instruments has been a great help in this work. The determination of temperatures in various parts of the furnace is an important matter; and the thermoelectric pyrometer has great possibilities of value for this purpose. Instruments for steam metering are also worthy of more attention than seems to have been accorded to them by power station engineers.

In discussing Mr. Wait's paper, Mr. Francis Hodgkinson pointed out that low-pressure turbines are applicable for working not only in conjunction with non-condensing reciprocating engines in which the steam expansion is incomplete, but also in conjunction with engines designed for operating condensing. One very obvious reason for the beneficial results of low-pressure turbines is due to the large temperature drops as low steam pressures are reached, which in the low-pressure cylinder of the reciprocating engine are harmful because of condensation and re-evaporation as the cycles are reversed, which objectionable condition does not exist in the low-pressure turbine.

Mr. J. R. Bibbins stated that low-pressure turbine application resolves itself into two general classes. Firstly, those in which the turbine is unable to use exactly the same quantity of steam delivered by the primary motor, as in the case of the rolling-mill engine discussed by Mr. Wait; and secondly, those in which the turbine utilizes all of the steam from the primary motor and hence operates in some respects as the low-pressure cylinder of a compound or triple-expansion system, such as the case of a non-condensing electric unit, with which the turbo-generator may be operated in electrical parallel without the use of a turbine governor.

Tungsten Lamp Patent.

A patent issued Dec. 3 to Mr. John Allen Heaney relates to a tungsten lamp, the peculiarity of which consists in the use of a plurality of tungsten filaments in the form of hairpins in series, and each filament supported at the loop by a fine spiral spring. The application for the patent was filed Jan. 5, 1905, and the specification refers to another application filed Dec. 29, 1904, in which is disclosed the use of tungsten and other refractory materials for making incandescent lamp filaments. It is stated to be impossible to wind a tungsten filament back and forth on a spiral, as is done in the tantalum lamp; for this reason a plurality of individual filaments are connected in series by conducting supports, which, however, are of such current-carrying capacity that they remain practically cold. Since only dense and homogeneous pure tungsten filaments can be worked at high efficiency, and since such filaments have a high specific conductivity, the inventor found it necessary not only to mount a plurality of such filaments in the form of hairpins in series within the bulb, but also to make the filaments of extremely small cross-section in order that the lamp containing them may be operated upon ordinary commercial voltages, such as 110 volts. Furthermore, owing to the plasticity of the tungsten filament when in use and its brittleness when cold, means must be provided which will allow the filament to be supported without undue strain in the desired position, and this is accomplished by the use of a resilient support at the loop of the filament. The patent includes a description in much detail of the process of manufacture of the tungsten filament.

CURRENT NEWS AND NOTES.

NEW YORK LIGHTING.—Bids were opened on Dec. 10 by Commissioner John H. O'Brien for the lighting of New York City next year. No bids were received for supplying gas, but the city will pay 75 cents a 1000 cu. ft. pending the decision of the courts in the suit of the city against the gas companies. In the main the bids for furnishing electricity were the same as for the present year. Arc lamps will cost the city $100 each for the first 5000 lamps and $95 for each additional lamp. Eventually, when the number reaches 7000, the price of all such lamps per year will be $95 each. Incandescent lamps will cost $22.50 each all over the city; energy for heat and other purposes, from 7½ to 10 centts a kw-hour, and energy for motors, 6 cents. The city's light bill this year will be between $3,500,000 and $4,000,000.

PORTLAND, ORE., LIGHTING.—A report and estimate of expenses of the city lighting department has been submitted to Mayor Lane, of Portland, Ore., by Thomas G. Greene, D. A. Pattulo and M. A. Fleischner, of the Executive Board. It favors a municipal plant for Portland. About $100,000 yearly is required to pay for electric light furnished by the Portland Railway, Light & Power Company. As the municipality grows, the report states, the expense of this department will increase. In view of this fact, the committee suggests that it would be well to investigate conditions, with the object of establishing a lighting plant, from power furnished by Bull Run River. The report of the committee states that Portland is a poorly lighted city at present, and recommends at least 75 additional arc lamps in various sections for next year. The contract with the Portland Railway, Light & Power Company will terminate Dec. 31, 1908, and the committee believes it would be wise to have immediate action, looking toward the erection of a municipal plant, so as to avoid renewing the present contract.

CENTRAL STATION ACCOUNTING.—Commissioner Maltbie of the Public Service Commission and representatives of the vraious lighting companies in and around New York City held a conference on Dec. 10 on the question of a uniform system of accounts and a special form of annual report. Robert A. Carter, vice-president of the Consolidated Gas Company, and Henry M. Edwards, auditor of the Edison Company, did most of the talking for the companies, while Adna F. Weber, chief statistician of the commission, aided Mr. Maltbie. It developed that the companies were anxious to agree on a uniform system of accounts, and that the National Electric Light Association had taken the matter up and appointed a committee to devise a plan. On the question of a time for making an annual report there was some difference of opinion, the commissioner favoring the middle of the year rather than the end, so that the companies' reports could be incorporated in the commission's annual report. The companies favored the end of the year, as their own reports were made up then and their books balanced, so that much extra labor would be saved. The conference adjourned, subject to call, without a decision.

DOUBLE OVERHEAD.—The local authorities of Richmond, Va., have refused to order the Virginia Passenger & Power Company to put in a double, instead of the single, overhead system, now in use, and have ordered instead the protection of the water mains, etc., by thorough and complete railbonding.

TRANSIT INSPECTORS.—The Public Service Commission in the First New York District has reported to the Civil Service Commission the appointment of 27 transit inspectors at an annual salary of $1,200. In transmitting the notice of appointments, Secretary Whitney said: "On the whole, I want to congratulate the commission upon the exceptionally good men that were turned out by this examination. The men that we have so far appointed, to my mind, are a remarkable set of men, and I know that it is an unexpected gratification to our commission that they were able to obtain good men at the salary offered."

THE GOLDFIELD STRIKE.—Advices from Goldfield, Nev., of Dec. 14, state that electricians, engineers and carpenters in the employ of the Nevada-California Power Company, all of whom are members of the local union affiliated with the American Federation of Labor, have returned to work under the agreement reached between the Federation officers and the Mine Owners' Association. This involves a 10 days' truce at the old wage scale pending the preparation of a new scale. The wife of a miner who deserted the Western Federation and returned to work was badly beaten by union pickets. She had been boarding some of the workmen and had openly expressed antipathy to the Western Federation. No arrests have been made, as only those have any right to a personal opinion in Goldfield who are in sympathy with the local despots.

DAMASCUS DYNAMOS.—A well-known American writer, Dr. Henry van Dyke, explored the oldest living city in the world, Damascus, in his recent trip in the Orient, and found it as much the "typical city of the Orient" as New York is of the Occident. It has electric lamps and trolley-cars, but, as Dr. van Dyke explains, in the January number of *Harper's Magazine*, these modern innovations no more alter its Oriental character than a bead necklace would alter the Venus of Milo. The people seem like characters out of the "Arabian Nights Entertainments," and a man was stabbed to death not 50 ft. from the author as he stood near the Ottoman Bank. Dr. van Dyke was surprised to meet so many Arabians who had been in America, and one citizen of Râshieyâ remarked: "You fellows come from America? What's the news there? Is Bryan elected yet? I voted for McKinley."

INTERESTING IF TRUE.—There have been made lately some extraordinary statements as to very long-distance wireless work, that were not afterwards confirmed. A dispatch from St. Petersburg of Dec. 11 says: "The Kiev station of the wireless telegraph line which the Russian government is constructing to connect Sebastopol with St. Petersburg, has succeeded in picking up Marconi trans-Atlantic messages, including a number of press dispatches, sent from the American side. Messages transmitted from Paris and Casablanca also have been picked up. The wireless system employed has given excellent results. Mr. Taft, the American Secretary of War, was approached while in this city for permission to install wireless communication between Shanghai and Manila. The distance from Glacé Bay, the point at which Marconi wireless messages are started for Irelnad, to Keiv, is approximately 3,750 miles."

A CONDUCTING HORSE.—It is well known that the horse is very sensitive to electrical effects, but this condition has not previously been utilized, except by jockeys and gamblers, in horse races. An ingenious device by which the horse is made a part of an electrical circuit has been reported to the War Department by Lieut. A. C. Knowles, 13th Infantry, at Fort Leavenworth, who has been making tests intended to permit telegraphic and telephonic communications between mounted operators. This will permit the mounted operator to transmit messages to his base wherever necessary without stopping his horse and is accomplished by placing a small piece of copper, properly connected to the instrument, against the animal's body, thus completing a ground connection through the horse's hoof. Conversation was carried on without difficulty between two operators separated by five miles, the horses standing in the grass.

GERMAN STRAPHANGERS.—A Marconi wireless message to the *New York Times*, of Dec. 14, says: "Another American importation, after long years of opposition, has fairly fought its way into Germany—the straphanger for street-car passengers who cannot find seats. This familiar trans-Atlantic institution will be introduced for the first time on the new lines of the Berlin municipal street railway system, which has proudly announced that its cars will be of the 'latest up-to-date American pattern, including cross-section seats, reversible, according to the direction the car is traveling, with space at the rear and front where passengers may stand and hold on to straps.' Hitherto nobody has been allowed to jam his way inside a German street car after the seats have been occupied. The law fixes the exact number of six as the limit for those who may stand on the front or the rear platforms, but any conductor who allows a passenger to stand inside is subject to police fines."

LIGHTING IN RIO.—Deputy U. S. Consul-General Joseph J. Slechta writes that the completion of the large power plant which is being constructed some 40 miles from the city of Rio de Janeiro will greatly facilitate the development and extension of the electric tramway system of the Brazilian capital, and it is expected that it will also bring about an immediate reduction in the price of electric lighting, both public and private. The charge for gas is about 8.45 cents per cubic meter. Electricity for ordinary private consumption costs for lighting purposes a little more than 21 cents per kw-hour, and for motor purposes the small consumer pays as high as 11½ cents per kw-hour, the charge diminishing to a minimum of perhaps 5 cents per kw-hour. The city pays about two-thirds of a cent per lamp per hour for its gas illumination and approximately 15 cents per hour for its electric arcs. Inasmuch as the gas supply of the city is controlled by the same corporation which furnishes electricity, and which is soon to have the advantage of an economically operated power plant, there is considerable local interest as to what the new price schedules will be.

CHINESE TELEGRAPH TRAFFIC.—Special advices from Pekin state that the policy of Japan in China is threatening to bring about a new crisis in Manchurian affairs, and, as a result of the course pursued by the Tokio Government, there is danger of Russia's canceling the Russo-Chinese Telegraph Convention signed last October. The failure of China to conclude a corresponding agreement with Japan will have the effect of annulling the agreement made by China and Russia and it may result in a Russo-Japanese convention under the terms of which China will be excluded from the Manchurian telegraph traffic in the same way that the Russo-Japanese postal agreement resulted in the possession of the Manchurian postal service by these two powers. Japan has 10 telegraph stations in Manchuria in violation of the treaty, and she has also committed, it is asserted, other acts of aggression. The Tokio Government maintains that China should concede its original demands: these embrace the recognition of the stations outside the railroad zone and the independence of the entire system of communication, the waiving of telegram royalties, the recognition of the Dalny-Sasebo cable, the granting of cable rights between Dalny and Chefoo, and special rates on the Chinese connecting lines; this last is a special privilege. In connection with this dispute it is interesting to note that the powers have persistently discouraged China from expecting any intervention in the premises. China's plight in Manchuria is aggravated by the commercial distress due to the lack of Chinese currency.

DARK BORDEAUX.—Following the lighting strike at Paris, there has been a similar disagreeable experience at Bordeaux. A cable dispatch from that city of Dec. 13 says: "The city is in utter darkness as the result of a strike of gas men and employees of the electric light company, who are demanding an increase in pay. All business houses have been compelled to close at nightfall."

ST. LAWRENCE WIRELESS.—U. S. Consul Almar F. Dickson, of Gaspé, advises that on Nov. 20, the Marconi wireless stations along the northern part of the Gulf of St. Lawrence were closed until next spring, all the vessels outward now taking the southerly course, making the service needless. The five stations closed are located at Belle Isle, Point Amour, Point Rich, Point au Maurier and Heath Point, Island of Anticosti.

WEATHER AND WIRES.—A severe storm struck both sides of the Atlantic last week, and did considerable damage. In England there was a very general interruption of telegraphic and telephonic traffic and messages from London for Paris came by way of New York in large numbers, over the cable, as direct service via the Channel circuits was impossible. In America, various districts suffered also from gales and snow storms of unusual severity. At Lynchburg, Va., the Southern Bell Telephone Company had 1200 telephones out of service on Dec. 14, the electric light and street railway systems were suspended, and the region around was encumbered with broken poles and wires. In like manner telegraph and telephone wires suffered through Pennsylvania and Delaware; lighting systems were cut out in New Jersey, and around Albany, Syracuse, N. Y., and Northern New York towns, trolley lines were tied up.

CABLE BURN-OUT RECORDS.—Mr. D. W. Roper, assistant operating engineer of the Chicago Commonwealth Edison Company, gave some very interesting information in a paper before the Western Society of Engineers, at Chicago, Dec. 13, on "Unusual Burn-outs in Underground Cables." Descriptions of a few cable burn-outs of considerable magnitude were given. In some of these burn-outs, the heat of the arc spread the trouble so that several ducts were destroyed. A point of special note was made that the burn-outs from internal causes of 9000-volt, 3-phase cables per 100 miles in use have been steadily on the decrease for several years. It is also remarkable that in this 9000-volt system which has been growing steadily and now aggregates 250 miles of cable, only one internal burn-out has been caused by a bad joint. This is considered a remarkable testimonial to the skill and carefulness of the joint makers, when it is remembered under what adverse conditions they must frequently work.

UNDERWRITERS' ELECTRIC ASSOCIATION.—The annual meeting of the electrical committee of the Underwriters' National Electric Association will be held in March, 1908, in New York City. The day and place of the meeting will be announced later. At usual, the provisions of the National Electrical Code as they now exist will be the principal matter for consideration, and it is requested that any desired change in, or addition to, the Code, be forwarded to C. W. Goddard, secretary, 55 Kilby Street, Boston, on or before Feb. 1, 1908, in order that it may be printed in the bulletin, and the committee and other interested parties may thus have opportunity to consider it in advance of the meeting. Final action on suggestions not received in season for consideration by the committee before the meeting, can only be taken by unanimous consent. As heretofore, the meeting will be open to all interested, and such persons are urged to be present and give the committee the advantage of their experience and advice.

NOVEL USE OF FLATIRONS.—The necessity arose recently in a steam power plant to replace a crank pin on the pressure side of a 500-hp cross-compound Russell engine. The new pin was 6 ins. in diameter with a taper of 1/64 in. and had to be fitted tightly into the disc, which was 5 ins. thick with a 12-in. shaft. To expand the disc by heating it with blow torches would have taken too long, besides making a dirty and unsatisfactory job. Several heating units formed of General Electric 6-lb. flatiron cores were grouped around an iron core 3¼ ins. in diameter and placed in the 6-in. hole in the crank disc. In four hours after the current was turned on the disc had expanded sufficiently to allow the crank pin to slip in. Although the heating units from the flatirons were at about white heat all of the time, they were not injured except that the brass tubing on two was slightly melted in one place. The heating units were replaced in the flatirons, and have since been in use for the last three months, one of them being in a laundry where their active service averages 40 hours each week. The man who thought of this novel and ingenious use remains unknown to fame, but with such originality ought to be "heard from again."

THE ECONOMIC WASTE OF ACCIDENTS.—A friend of the American Museum of Safety Devices and Industrial Hygiene has offered a prize of $100 for the best essay on the Economic Waste of Accidents. The committee of award consists of Richard Watson Gilder, George Gilmour and W. H. Tolman. Professor F. R. Hutton, past president of the American Society of Mechanical Engineers, is the chairman of the committee on admission of exhibits for the American Museum of Safety Devices and Industrial Hygiene, which occupies the entire fifth floor at 231 West Thirty-ninth Street, New York. The museum desires exhibits of devices and processes for safeguarding life and limb in connection with wood-working machinery, railway and marine transportation, mining and agriculture, manufacturing of all kinds. One exhibit already consists of specimens of 50 different kinds of dusts illustrating the occupational diseases; accompanying each is the photograph, a microscopic section of the lungs, showing the effect on the worker of coal, iron, brass, steel, wood and other dusts. There are also wax models of lungs and hands illustrating those occupational diseases which attack the bones and skin. All exhibits accepted by the committee on exhibits will be eligible for the gold medal offered by the *Scientific American* for the best device, exhibited at the museum, for safeguarding life and limb. All inquiries regarding exhibits should be sent to Dr. W. H. Tolman, Director, 231 West Thirty-ninth St., New York.

SERVICE COMMISSION EXPENSES.—There has been considerable criticism of the heavy expenses of the Public Service Commission of the First New York district, amounting already to far above $1,000,000 per year. Chairman Willcox says: "It must be understood that the Public Utilities Commission has assumed the duties of the Rapid Transit Commission, the Gas Commission and the State Railway Commission, so far as the latter affect this city. Printed statements of our proposed expenditures have been erroneous. Most of our payroll is, for instance, for our staff of engineers, and not for clerical work, as has been suggested. We are asking of the Board of Estimate $1,095,000, and with the $91,000 which the state will pay, we are spending $1,187,000. Now the last budget of the Rapid Transit Commission was something like $800,000, which the Board of Estimate readily granted. Our budget is $1,095,000, only a trifle more, when one considers that we have succeeded to the duties of the old Rapid Transit Commission as well as those of the Gas and State Railway Commissions. In regard to the item of $25,000 for advertising, I can only say that we must print advertisements for bids, with specifications, which require columns in the daily newspapers. We are at work now on the Fourth Avenue Subway of 23 miles, and this requires a great deal of advertising. Since the inception of the Public Utilities Board we have issued 600 orders in answer to complaints. We ask for $125,000 as extra charge for employees, and this covers the expense of inspectors to investigate complaints regarding traffic during rush hours and later in the evening."

Hydro-Electric Transmission Plant of the Rockingham Power Company.

By J. S. Viehe.

THE site of the hydro-electric plant of the Rockingham Power Company is located on the Yadkin River at a point about 7 miles northeast of the town of Rockingham, N. C., and 16 miles north of the boundary line between North and South Carolina. With a 50-ft. dam, the total power for delivery to customers is 22,500 kilowatts 11 hours per day, as calculated from government reports. Besides this power there is a large amount available from six to nine months out of the year, which can be used in those industries where the cost of energy is of vital importance and continuous operation for the entire year is not essential. About 11,250 kilowatts is available every day in the year, known as "A" power, and 11,250 kilowatts is available 90 per cent of the time, and known as "B" power.

The market for the energy is located in a very fertile section of the cotton belt served by the main lines of the Seaboard and Atlantic Coast Line Railroads. The various towns are so located as to be economically supplied by two main transmission lines. One of these is to be carried from the power house to Wilmington, a distance of 110 miles, at which point it is expected that 5000 horse-power will be taken as soon as the plant is put in operation, and that this load will increase to 10,000 horse-power in a few years. The route of the line is near and parallel to the Seaboard Air Line track to Wilmington, thus being near all the towns on the railroad. This line is to serve the Scotland Mill 400 horse-power and the Dickson Mill 200 horse-power at Laurinburg, N. C., and about 1400 horse-power to the Dresden, Lumberton and National Mills, at Lumberton, N. C., besides the energy for lighting circuits in these towns, as well as many others located along and in the immediate vicinity of the line. The second line will have its main points of delivery at Rockingham, McColl, Bennettsville, Darlington and Hartsville, furnishing 1400 horse-power to mills in Rockingham, 1600 horse-power to the Marlboro Cotton Mills at McColl and Bennettsville, 2000 horse-power to the Darlington Manufacturing Company, 1500 horse-power to the Hartsville Cotton Mill, and 2300 horse-power to the Carolina Fibre Company, besides energy for lamp and motor circuits in the various towns The majority of the mills are at present driven by steam, for which reason it is being found that there is a considerable demand for secondary, or "B," power, the mills using the latter being so arranged that steam power can be used in case the power company is unable to furnish electrical energy owing to low water.

The primary, or "A," power is used largely for the supply of public service corporations, who are either unable or unwilling to provide both steam and electrical equipments. A number of mills also take this energy, thus obtaining a reliable supply and enjoying all the benefits of greater production.

The general layout of the development as it will appear when completed is shown in an accompanying engraving from a lithograph which was prepared from plans to indicate the general appearance and relation of the dam, power house, head water, etc. At the point selected for the dam there is a hill on each side of the river, between which the main dam, 1420 ft. long, is carried. The dam, of concrete and large ballast stone, is 50 ft. high, 10 ft. thick at the top and 50 ft. thick at the base. The up-stream face is vertical, the down-stream side being curved to give a long toe. The dam is built in a straight line from shore to shore, and this entire length is used as a roll-away to carry off large volumes of water during freshets. The pondage will extend up-stream about 7 miles, giving an area of water of approximately 2500 acres.

POWER HOUSE.

It will be noted from Fig. 1 that the power house is not located in the main stream, but that the head-water is carried around a hill in a canal to the power house. This canal is a natural one, requiring only a small amount of excavation to give sufficient passage for the water. By this method of development, the power house is protected from floods, and in this particular case a certain amount of head is gained by reason of rapids between the dam and the point where the tailrace enters the river. At the end of this canal is placed the head-gate wall, through which the feeders for the various water-wheels are carried. Just below the head-gate wall is the power house, of brick, built on arches of concrete. The power house is designed to contain six three-phase, 60-cycle, 4000-volt, 3000-kw alternators and transformers for raising the potential from 4000 to 60,000 volts. The transformers, as well as all high-tension apparatus, are to be placed in fireproof compartments. All switches are operated electrically from a central bench-board, thus putting the entire control of the station in the hands of one man. The generator room is 260 ft. x 100 ft. and 40 ft. high, and the portion used for transformers, controlling apparatus, etc., is 160 ft. x 75 ft. and 40 ft. high with three floors. Fig. 2 shows the general arrangement. A traveling crane, running the entire length of the building and operated electrically, is to be used in installing the machinery and also in repairing apparatus.

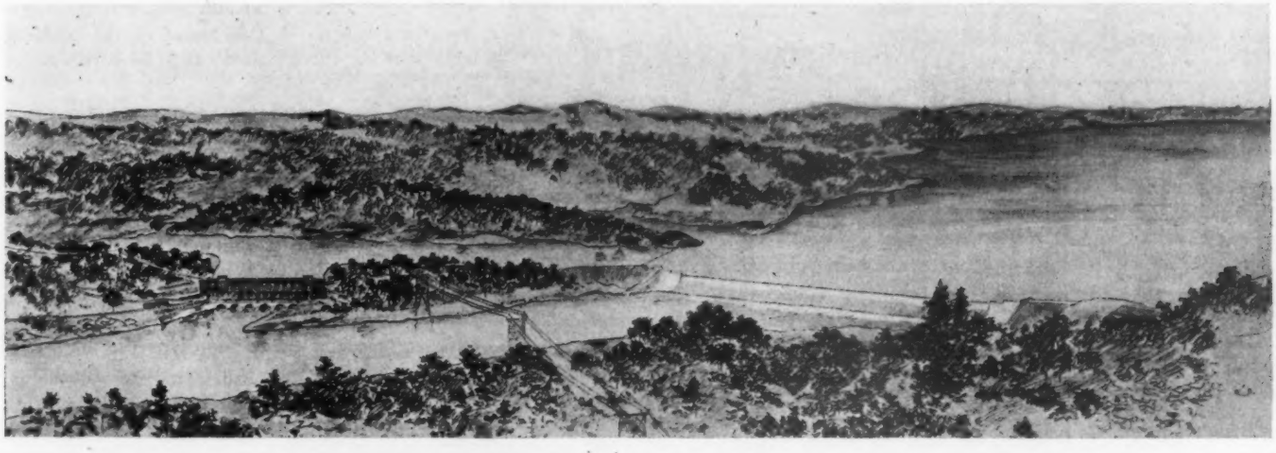


FIG. 1.—HYDRO-ELECTRIC TRANSMISSION STATION OF THE ROCKINGHAM POWER COMPANY AT ROCKINGHAM, N. C.

The transformers are 1000-kw water-cooled units, three connected delta and delta forming a group for each 3000-kw generator. Normally, the station will be operated with transformer-generator units, but a tie-bus is to be provided so that the failure of a certain group of transformers will not necessarily put that generator out of commission.

The exciting current for these alternators is to be derived from three 150-kw, 220-volt generators driven by separate water-wheels.

The first installation will comprise the necessary apparatus for three 3000-kw alternators or one-half the contemplated sta-

tion equipment. All of the apparatus will be furnished and installed by the General Electric Company. The waterwheels are of the inward-flow, turbine type, furnished by the S. Morgan Smith Company, of York, Pa. The governors will be of the Lombard type.

TRANSMISSION LINE.

The transmission system, as at present laid out, comprises a total length of line of 200 miles, being arranged in two circuits as noted, one running to Wilmington, N. C., and the other to Darlington and Hartsville, S. C. On account of the great durability of steel, and the small increased cost of steel towers over wooden poles, it has been decided to use galvanized towers throughout on these lines. The towers are of the standard windmill type, 55 ft. to the highest point, where the ground wire is attached, and 45 ft. to the lowest transmission wire. The towers are anchored to the ground by means of extensions on each post. These anchor pieces are of angle iron with cross pieces at the bottom, and are buried 6 ft. in the ground. The three transmission wires are arranged in a triangle, with 7-ft. sides, two wires being in a horizontal plane and one below. Telephone wires are to be strung on the same towers, 6 ft. below the transmission wires, and will connect the power house and all sub-stations on the high-tension line.

On level ground the towers are to be spaced 600 ft. apart, but in hilly country spans as long as 900 ft. will be used in passing from hill to hill. Great care is being used to insure a

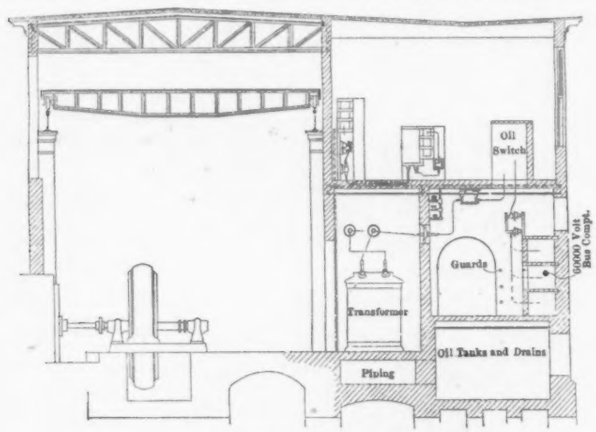


FIG. 2.—CROSS-SECTIONAL VIEW OF POWER HOUSE.

certain amount of sag and give sufficient clearance above ground in spans where one support is higher than the other. With the voltage to be used on the line, 60,000 volts, No. 1 copper cable for each conductor is sufficient to carry the electricity. At each sub-station switches are to be placed in the main line by means of which the section of line between that station and the next station can be cut out. By means of these switches, in case of trouble on the line, the section in which such trouble exists can be quickly determined.

A special insulator for this line has been designed by the joint efforts of the company's engineers and the R. Thomas Company's engineers, which, judging from tests, promises to give thorough satisfaction. With this insulator, the ground cable above the transmission wires, and lightning rods on each tower, it is thought that troubles due to lightning will be reduced to a minimum. As it is sometimes difficult to get satisfactory operation of a telephone system when the wires are carried close to 60,000-volt conductors, it has been decided to use a telephone insulator suitable for 10,000-volt work which it is thought will give sufficient insulation to insure good service. At telephone stations a transformer, with secondary grounded, is to be used to protect the user from shocks from the telephone line.

SUB-STATIONS.

In each locality where energy is to be supplied a union sub-station will be constructed containing transformers, switches and all necessary apparatus for reducing the voltage from 60,000 to a suitable potential for distribution to the various consumers. These buildings are to be thoroughly fireproof in all respects, and are to be provided with oil pump, water pump and means for repairing transformers. On account of the necessary space required for 60,000-volt apparatus, it has been found desirable to arrange the building with two stories, the first con-

FIG. 3.—DAM IN PROCESS OF CONSTRUCTION.

taining the transformers, pumps, etc., and the second story containing both high-tension and low-tension switches, the lightning arresters requiring nearly the full height of the building. The electrical apparatus for these stations is to be furnished by the General Electric Company.

CONSTRUCTION.

The building of the complete works requires the placing of 120,000 cu. yds. of concrete and the excavation of 400,000 cu. yds. of material. Of this amount, about 60 per cent of the concrete has been placed and about 30 per cent of the excavation has been done. The method of building the dam has been by means of building crib coffer dams around each section of the dam and carrying the concrete to this section with two cables strung across the river directly over the work. Railroads built on top of the coffer dams on each side of the main dam serve to convey ballast, stone and concrete from the shore. There are also traveling derricks on these tracks which place the concrete and ballast stone. It will be noted that there are two independent methods of building, the cable method and derrick method, which together give a total capacity of 400

FIG. 4.—UP-STREAM SIDE OF DAM ACROSS THE YADKIN RIVER.

cu. yds. per day. In building the dam, sluice ways 12 ft. sq. have been left at certain intervals to carry the flow of the river when the dam is completed the full width of the stream. When it is desired to fill these holes, timber gates will be let down on the up-stream side and the work of filling in with concrete carried on from the down-stream side.

The concrete is placed in wooden forms, which are wired to the interior of the dam and removed after the concrete is suffi-

LIBRARY

ciently hard. For getting all of the material to the site of the development, a spur track was built from the Seaboard Air Line a distance of about 3 miles. This track is owned by the Rockingham Power Company. In an undertaking of this kind the layout of the mixing plant is of great importance, for upon this very largely depends the economy with which the work is accomplished. A rock crushing plant was not required, as an abundance of good gravel is found near the railroad and hauled for about 3 miles over this track. Both sand and gravel are brought to the site in this way. At the end of the track a trestle has been built out over low ground, thus providing space for bins into which the contents of the cars are dumped. The cement is stored in sheds along the track and near this trestle. At the end of the trestle there is a small house from which cement is carried to the lower level through a chute. On the ground underneath the bins small cars are loaded with cement, sand and gravel and then pushed by hand to an elevator, which raises the material to the mixers. After being mixed, the concrete is carried to the work by cable and cars as stated.

At the power house the arrangement for storage of material is much the same as at the dam. The concrete is placed by cable, assisted by stiff-legged derricks. The cable towers are placed each side of the power house, and are so arranged that they can be moved latterly to cover all parts of the structure. About one-half of the total amount of concrete required for the power house has been placed. When the work is in full swing, a force of 1000 men, consisting chiefly of negroes, is required.

No towers have yet been erected for the transmission line, but anchor pieces have been set for approximately 40 miles of line. It is the intention to place the anchor pieces first, and allow the ground to settle before erecting the towers. The clearing is 60 ft. wide for a single line and 90 ft. for a double line. Besides this clearing, any trees which by falling would touch the wires are cut down.

The construction work is under the general direction of the Federal Construction Company, of Boston, the W. R. Bonsal Company being the builders of the dam, power house, abutments, etc. The Rockingham Power Company has its headquarters at Wilmington, N. C. Mr. M. F. H. Gouverneur is president of the company and Mr. C. E. Warner, whose office is at Rockingham, is the company's contract agent. Lockwood, Greene & Company, of Boston, have furnished general plans and specifications for the entire undertaking. The project has been financed by the Colonial Securities Company, of Boston; the Electric Bond & Share Company, of New York, and Hugh MacRae & Company, of Wilmington, N. C.

A Directive System of Wireless Telegraphy.

By E. Bellini and A. Tosi.

A CLOSED oscillator circuit, placed in a vertical plane, does not radiate equally in every direction of the horizontal plane like the open-rod oscillator, or antenna, employed in the usual wireless telegraph system. Lines of electric force detach themselves from the closed oscillator and extend to the earth, such lines being propogated chiefly in the plane of the circuit (Fig. 1); the radiation is zero in a direction normal to the plane of the closed circuit.

In consequence of this, a system which makes use of the properties of closed radiating circuits is of itself alone a directive transmitter system. Since, however, the radiation from closed oscillators is weaker than that from open ones, it was necessary to prove that, when such closed circuits are employed, the distances reached in ordinary radiotelegraphic communication could be easily attained. Further, in actually obtaining radiotelegraphic communication by the employment of closed circuits it was also desirable to make certain that the energy required was not excessive.

The experiments were made by the authors, thanks to the kind permission vouchsafed by the French Government, between three stations on the Normandy coast. These stations were erected in the neighborhood of Dieppe, Havre and Barfleur, each station being provided with a mast 50 meters in height. Since one mast only was used to sustain the closed radiating circuit, this latter was given a triangular shape (Fig.

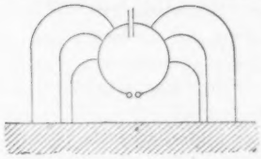


FIG. 1.—CLOSED RADIATING CIRCUIT.

3) in place of the circular form of Fig. 1. The symmetrical sides of the triangle were formed of a trellis of nine parallel copper strands, spaced 20 cm apart, each strand consisting of seven wires 0.9 millimetre in diameter. The distance between the upper ends of the trellis forming the armatures of the condenser was 2.5 metres; that between the lower extremities, ending at 2 metres from the ground, about 55 metres. The con-

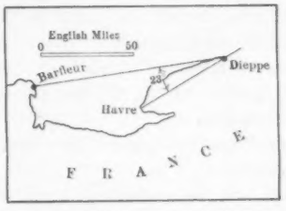


FIG. 2.—MAP OF TRANSMISSIONS.

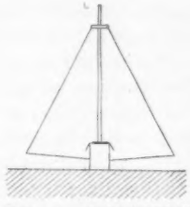


FIG. 3.—TRIANGULAR RADIATING CIRCUIT.

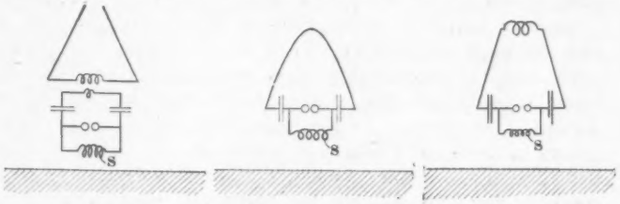
ductors of the trellis were all joined together at the base, and two wires of the same strand of the trellis served to make connection with the apparatus.

The distance between the Dieppe and Havre stations is about 90 kilometres; that between Dieppe and Barfleur about 170 kilometres. The angle enclosed between the directions Dieppe-Havre and Dieppe-Barfleur is about 23 degrees. The line joining Dieppe with Barfleur lies entirely over sea (Fig. 2), while

FIGS. 4 AND 5.—DIAGRAMS OF ARRANGEMENT FOR EXCITING OSCILLATOR CIRCUIT.

the transmission Dieppe-Havre has to pass over land the whole way; in consequence, Dieppe can be considered as being radiotelegraphically equidistant from Havre and Barfleur.

Dieppe was chosen as the transmitting station and Havre and Barfleur as receiving stations. The energy for the transmission was supplied by a storage battery, the current from which, broken by a mercury interrupter of the Foucault type, passed to one or two induction coils of 30-cm spark-length. The



FIGS. 6, 7 AND 8.—DIAGRAMS OF ARRANGEMENT FOR EXCITING OSCILLATOR CIRCUIT.

receiving stations were equipped for the reception with a Ferrié electrolytic detector connected to an ordinary vertical antenna and to earth.

Closed Oscillator Circuit at the Transmitter.

Figs. 4 to 8 represent diagrammatically several arrangements which have been used for exciting the closed oscillator circuit of the transmitter, the plane of which was placed in the direction

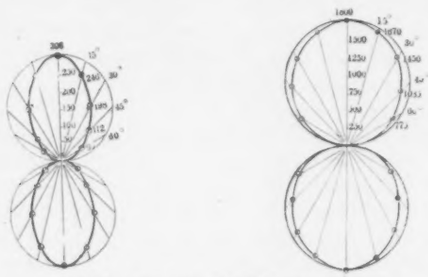
of the receiving station. It was found that, no matter which kind of transmitter circuit was used, the receiving station was always able to get the signals sent by the Dieppe station; but the arrangements which have given the best results are those shown in Figs. 5 and 6. On turning the plane of the transmitter circuit around its vertical axis the strength of the reception diminished to zero, the limiting angle naturally depending on the strength of the transmission and the sensitiveness of the receiving apparatus. But when the plane of the transmitter circuit was perpendicular to a line from Dieppe to the receiving station, the reception was always strictly zero.

The power employed in the course of the experiments in no case exceeded 500 watts; with the arrangements as shown in Figs. 4, 7, 8 the amount used was considerably less than this.

The energy diagram, *i. e.*, of the quantity of the energy radiated relatively in the different directions throughout any chosen period of time, was traced while the arrangement shown in Fig. 6 was used for the transmission 1. For the reception, a 30-metre vertical wire was erected at a distance of 500 meters from the transmitter, and joined to a Duddell thermo-galvanometer, one terminal of which was earthed. The observations were made in the following manner:

The transmitter circuit was turned through a definite angle, the first position being in the direction of the thermo-galvanometer and the last at 90 deg. from this.

Fig. 9 is the diagram of the energy emitted in the different directions, while the diagram shown in Fig. 10—of which the *radii vectores* are the square roots of the vectors of the energy



FIGS. 9 AND 10.—ENERGY DIAGRAMS.

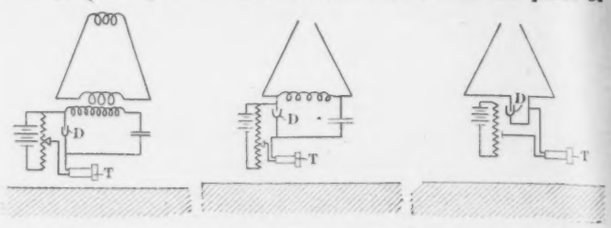
diagram of Fig. 9—is that of the electromagnetic field intensity in the different directions; it is formed of two equal tangent curves which approximate closely to two circles. As a result, owing to the unavoidable errors and the small distance at which the observations were made, it can be said that the diagram of electromagnetic field intensity is composed of two tangent circles, and the energy diagram of two curves whose equation is $E = E_0 \cos^2 \alpha$.

It is impossible to say from *a priori* considerations which of these two diagrams should be considered for the determination of the variation in the transmitter effect according to the position given to the transmitter; this depends exclusively on the receiver. If this latter responds to the total energy received (as the bolometer, thermo-galvanometer, thermo-couple) it is the energy diagram (Fig. 9) which should be chosen. If, on the other hand, the receiver responds to the maximum intensity of the electromagnetic field (coherer and, probably, magnetic detector) the diagram to be applied is that of the electromagnetic field (Fig. 10). Finally, should the receiver be responsive partly to the total energy and partly to the maximum of the electromagnetic field, a diagram of form intermediate between the two diagrams previously considered would represent the conditions; and probably the electrolytic detector falls under this last classification.

Closed Oscillatory Circuits for the Reception.

A radiotelegraphic transmitting station creates an electromagnetic field which at a great distance is composed of vertical lines of electric force and horizontal lines of magnetic force. An oscillatory circuit, placed vertically in the field produced in this way, will be influenced in a different manner according to the angle which its plane makes with the direction of propogation of the electromagnetic waves; and since the electromagnetic fields depend, the one upon the other, it will suffice to examine the influence of either one of these fields; let it be the action of the magnetic field.

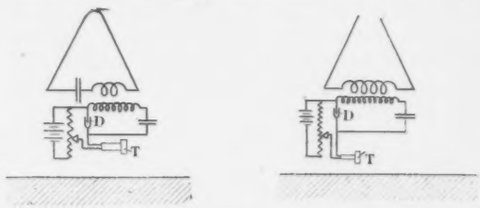
If the plane of the receiver circuit be perpendicular to the direction of propagation, the magnetic flux which is enclosed is always zero, and hence the induced e. m. f. is also zero. Conversely, if the plane of the receiver circuit is in the plane of



FIGS. 11, 12 AND 13.—DIAGRAMS OF RECEIVING CIRCUITS.

communication, the variation of the magnetic flux reaches a maximum; and in consequence there is a maximum of the induced e.m.f. In intermediate positions the e.m.f. varies according to the cosine of the angle which the direction of propagation of the waves makes with the plane of the closed oscillatory receiver (resouator) circuit. It follows that the diagram of the e. m. f. induced in a closed oscillatory circuit should be formed of two tangent circles; the energy diagram should be the same as that of Fig. 9; the diagram of intensity of reception will be either one or other of the two according to the type of detector used, as previously pointed out.

In order to see if in practice these theoretical predictions



FIGS. 14 AND 15.—DIAGRAMS OF RECEIVING CIRCUITS.

could be realized a series of experiments on the reception was made at the stations of Havre and Barfleur, at both of which the aerial was a closed oscillatory circuit; the Dieppe station transmitted with the ordinary vertical antenna.

At the receiving stations the experiments were from preference made with the arrangements shown diagrammatically in Figs. 11 to 15, always with satisfactory results. The reception attained its maximum when the plane of the receiver circuit was in the plane common to the transmitting and receiving

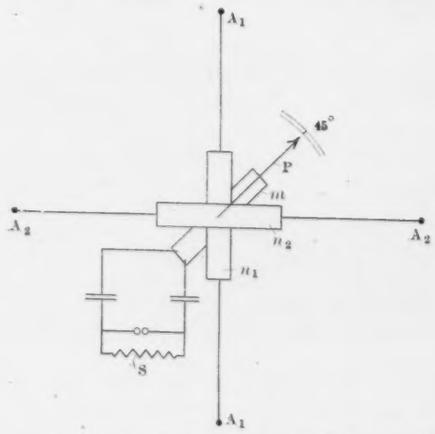


FIG. 16.—DIAGRAM OF INDUCTIVE EXCITATION APPARATUS.

stations; the reception was zero in the direction at right angles to this, and intermediate at intermediate positions.. In some cases a very small angular displacement of the plane of the circuit, with reference to the most advantageous direction, was sufficient to annul the reception.

THE ELECTRICAL WORLD'S

MOONLIGHT TABLES FOR 1908

COMPILED BY H. W. FRUND

These schedules are made up on local mean time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made.

JANUARY, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.15 P.M.	2	6.25 A.M.	1	5.15 P.M.	2	6.25 A.M.
2	5.15 "	3	6.25 "	2	5.15 "	3	6.25 "
3	5.15 "	4	6.25 "	3	5.15 "	4	6.25 "
4	5.15 "	5	6.25 "	4	5.15 "	5	6.25 "
5	5.15 "	6	6.25 "	5	5.15 "	6	6.25 "
6	5.15 "	7	6.25 "	6	5.15 "	7	6.25 "
7	5.15 "	8	6.25 "	7	5.15 "	8	6.25 "
8	5.20 "	9	6.25 "	8	9.40 "	9	6.25 "
9	5.20 "	10	6.25 "	9	10.50 "	10	6.25 "
10	5.20 "	11	6.25 "	10	11.50 "	11	6.25 "
11	5.20 "	11	12.00 M.	11	—	—	—
12	12.55 A.M.	12	6.25 A.M.	12	12.55 A.M.	12	6.25 A.M.
13	5.20 P.M.	12	12.00 M.	13	1.55 "	13	6.20 "
14	1.55 A.M.	13	6.20 A.M.	14	2.55 "	14	6.20 "
15	5.25 P.M.	13	12.00 M.	15	3.55 "	15	6.20 "
16	2.55 A.M.	14	6.20 A.M.	16	4.50 "	16	6.20 "
17	5.25 P.M.	14	12.00 M.	17	No light.	17	No light.
18	5.25 "	15	12.00 "	18	No light.	18	No light.
19	5.25 "	16	12.00 "	19	No light.	19	No light.
20	5.25 "	17	12.00 "	20	5.30 P.M.	20	8.05 P.M.
21	5.30 "	18	12.00 "	21	5.30 "	21	9.05 "
22	5.30 "	19	12.00 "	22	5.35 "	22	10.00 "
23	5.30 "	20	12.00 "	23	5.35 "	23	11.00 "
24	5.30 "	21	12.00 "	24	5.35 "	24	12.00 M.
25	5.35 "	22	12.00 "	25	5.35 "	26	1.00 A.M.
26	5.35 "	23	12.00 "	26	5.40 "	27	2.10 "
27	5.35 "	24	12.00 "	27	5.40 "	28	3.15 "
28	5.35 "	26	1.00 A.M.	28	5.40 "	29	4.25 "
29	5.40 "	27	2.10 "	29	5.40 "	30	5.35 "
30	5.40 "	28	3.15 "	30	5.45 "	31	6.15 "
31	5.40 "	29	4.25 "	31	5.45 "	1	6.10 "
	5.40 "	30	5.35 "				
	5.45 "	31	6.15 "				
	5.45 "	1	6.10 "				

FEBRUARY, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.45 P.M.	2	6.10 A.M.	1	5.45 P.M.	2	6.10 A.M.
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3	5.50 "	4	6.10 "	3	5.50 "	4	6.10 "
4	5.50 "	5	6.10 "	4	5.50 "	5	6.10 "
5	5.50 "	6	6.10 "	5	5.50 "	6	6.10 "
6	5.50 "	7	6.05 "	6	5.50 "	7	6.05 "
7	5.50 "	8	6.05 "	7	10.45 "	8	6.05 "
8	5.55 "	9	6.05 "	8	11.50 "	9	6.05 "
9	5.55 "	9	12.00 M.	9	—	—	—
10	12.50 A.M.	10	6.05 A.M.	10	12.50 A.M.	10	6.05 A.M.
10	5.55 P.M.	10	12.00 M.	11	1.50 "	11	6.00 "
11	1.50 A.M.	11	6.00 A.M.	12	2.45 "	12	6.00 "
11	5.55 P.M.	11	12.00 M.	13	3.45 "	13	6.00 "
12	2.45 A.M.	12	6.00 A.M.	14	4.25 "	14	5.55 "
12	6.00 P.M.	12	12.00 M.	15	No light.	15	No light.
13	6.00 "	13	12.00 "	16	No light.	16	No light.
14	6.00 "	14	12.00 "	17	No light.	17	No light.
15	6.00 "	15	12.00 "	18	6.05 P.M.	18	7.55 P.M.
16	6.05 "	16	12.00 "	19	6.05 "	19	8.55 "
17	6.05 "	17	12.00 "	20	6.10 "	20	9.55 "
18	6.05 "	18	12.00 "	21	6.10 "	21	10.55 "
19	6.05 "	19	12.00 "	22	6.10 "	22	12.00 M.
20	6.10 "	20	12.00 "	23	6.15 "	24	1.00 A.M.
21	6.10 "	21	12.00 "	24	6.15 "	25	2.10 "
22	6.10 "	22	12.00 "	25	6.15 "	26	3.15 "
23	6.15 "	24	1.00 A.M.	26	6.15 "	27	4.25 "
24	6.15 "	25	2.10 "	27	6.15 "	28	5.25 "
25	6.15 "	26	3.15 "	28	6.15 "	29	6.20 "
26	6.15 "	27	4.25 "	29	6.20 "	1	5.35 "
27	6.15 "	28	5.25 "				
28	6.15 "	29	5.35 "				
29	6.20 "	1	5.35 "				

MARCH, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.20 P.M.	2	5.35 A.M.	1	6.20 P.M.	2	5.35 A.M.
2	6.20 "	3	5.35 "	2	6.20 "	3	5.35 "
3	6.20 "	4	5.30 "	3	6.20 "	4	5.30 "
4	6.25 "	5	5.30 "	4	6.25 "	5	5.30 "
5	6.25 "	6	5.30 "	5	6.25 "	6	5.30 "
6	6.25 "	7	5.30 "	6	6.25 "	7	5.30 "
7	6.25 "	8	5.25 "	7	10.40 "	8	5.25 "
8	6.25 "	9	5.25 "	8	11.40 "	9	5.25 "
9	6.30 "	10	5.20 "	9	—	—	—
10	6.30 "	10	12.00 M.	10	12.40 A.M.	10	5.20 A.M.
11	1.30 A.M.	11	5.20 A.M.	11	1.30 "	11	5.20 "
11	6.30 P.M.	11	12.00 M.	12	2.20 "	12	5.20 "
12	2.20 A.M.	12	5.20 A.M.	13	3.00 "	13	5.15 "
12	6.30 P.M.	12	12.00 M.	14	3.45 "	14	5.15 "
13	6.30 "	13	12.00 "	15	No light.	15	No light.
14	6.35 "	14	12.00 "	16	No light.	16	No light.
15	6.35 "	15	12.00 "	17	No light.	17	No light.
16	6.35 "	16	12.00 "	18	No light.	18	No light.
17	6.35 "	17	12.00 "	19	6.40 P.M.	19	8.50 P.M.
18	6.40 "	18	12.00 "	20	6.40 "	20	9.50 "
19	6.40 "	19	12.00 "	21	6.40 "	21	11.00 "
20	6.40 "	20	12.00 "	22	6.40 "	22	12.00 M.
21	6.40 "	21	12.00 "	23	6.45 "	24	1.10 A.M.
22	6.40 "	22	12.00 "	24	6.45 "	25	2.15 "
23	6.45 "	24	1.10 A.M.	25	6.45 "	26	3.15 "
24	6.45 "	25	2.15 "	26	6.45 "	27	4.10 "
25	6.45 "	26	3.15 "	27	6.50 "	28	4.55 "
26	6.45 "	27	4.10 "	28	6.50 "	29	4.50 "
27	6.50 "	28	4.55 "	29	6.50 "	30	4.50 "
28	6.50 "	29	4.50 "	30	6.50 "	31	4.50 "
29	6.50 "	30	4.50 "	31	6.50 "	1	4.45 "
30	6.50 "	31	4.50 "				
31	6.50 "	1	4.45 "				

APRIL, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.50 P.M.	2	4.45 A.M.	1	6.50 P.M.	2	4.45 A.M.
2	6.55 "	3	4.45 "	2	6.55 "	3	4.45 "
3	6.55 "	4	4.40 "	3	6.55 "	4	4.40 "
4	6.55 "	5	4.40 "	4	6.55 "	5	4.40 "
5	6.55 "	6	4.40 "	5	10.30 "	6	4.40 "
6	6.55 "	7	4.35 "	6	11.25 "	7	4.35 "
7	7.00 "	8	4.35 "	7	—	—	—
8	7.00 "	8	12.00 M.	8	12.15 A.M.	8	4.35 A.M.
9	1.00 A.M.	9	4.35 A.M.	9	1.00 "	9	4.35 "
9	7.00 P.M.	9	12.00 M.	10	1.45 "	10	4.35 "
10	1.45 A.M.	10	4.35 A.M.	11	2.20 "	11	4.30 "
10	7.00 P.M.	10	12.00 M.	12	2.50 "	12	4.30 "
11	7.00 "	11	12.00 "	13	No light.	13	No light.
12	7.05 "	12	12.00 "	14	No light.	14	No light.
13	7.05 "	13	12.00 "	15	No light.	15	No light.
14	7.05 "	14	12.00 "	16	No light.	16	No light.
15	7.05 "	15	12.00 "	17	7.10 P.M.	17	8.50 P.M.
16	7.05 "	16	12.00 "	18	7.10 "	18	10.00 "
17	7.10 "	17	12.00 "	19	7.10 "	19	11.00 "
18	7.10 "	18	12.00 "	20	7.10 "	21	12.10 A.M.
19	7.10 "	19	12.00 "	21	7.10 "	22	1.15 "
20	7.10 "	21	12.10 A.M.	22	7.15 "	23	2.20 "
21	7.10 "	22	1.15 "	23	7.15 "	24	3.00 "
22	7.15 "	23	2.20 "	24	7.15 "	25	3.40 "
23	7.15 "	24	3.00 "	25	7.15 "	26	4.10 "
24	7.15 "	25	3.40 "	26	7.15 "	27	4.10 "
25	7.15 "	26	4.10 "	27	7.20 "	28	4.10 "
26	7.15 "	27	4.10 "	28	7.20 "	29	4.05 "
27	7.20 "	28	4.10 "	29	7.20 "	30	4.05 "
28	7.20 "	29	4.05 "	30	7.20 "	1	4.05 "
29	7.20 "	30	4.05 "				
30	7.20 "	1	4.05 "				

MAY, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.20 P.M.	2	4.00 A.M.	1	7.20 P.M.	2	4.00 A.M.
2	7.25 "	3	4.00 "	2	7.25 "	3	4.00 "
3	7.25 "	4	4.00 "	3	7.25 "	4	4.00 "
4	7.25 "	5	4.00 "	4	7.25 "	5	4.00 "
5	7.25 "	6	3.55 "	5	11.00 "	6	3.55 "
6	7.25 "	7	3.55 "	6	11.40 "	7	3.55 "
7	7.30 "	8	3.55 "	7	—	—	—
8	7.30 "	9	3.55 "	8	12.20 A.M.	8	3.55 A.M.
9	7.30 "	9	12.00 M.	9	12.50 "	9	3.55 "
10	1.20 A.M.	10	3.55 A.M.	10	1.20 "	10	3.55 "
10	7.30 P.M.	10	12.00 M.	11	1.50 "	11	3.50 "
11	1.50 A.M.	11	3.50 A.M.	12	2.15 "	12	3.50 "
11	7.30 P.M.	11	12.00 M.	13	2.40 "	13	3.50 "
12	7.35 "	12	12.00 "	14	No light.	14	No light.
13	7.35 "	13	12.00 "	15	No light.	15	No light.
14	7.35 "	14	12.00 "	16	No light.	16	No light.
15	7.35 "	15	12.00 "	17	7.35 P.M.	17	10.00 P.M.
16	7.35 "	16	12.00 "	18	7.40 "	18	11.00 "
17	7.35 "	17	12.00 "	19	7.40 "	19	12.00 M.
18	7.40 "	18	12.00 "	20	7.40 "	21	1.00 A.M.
19	7.40 "	19	12.00 "	21	7.40 "	22	1.40 "
20	7.40 "	21	1.00 A.M.	22	7.40 "	23	2.20 "
21	7.40 "	22	1.40 "	23	7.45 "	24	2.50 "
22	7.40 "	23	2.20 "	24	7.45 "	25	3.20 "
23	7.45 "	24	2.50 "	25	7.45 "	26	3.40 "
24	7.45 "	25	3.20 "	26	7.45 "	27	3.40 "
25	7.45 "	26	3.40 "	27	7.45 "	28	3.40 "
26	7.45 "	27	3.40 "	28	7.45 "	29	3.40 "
27	7.45 "	28	3.40 "	29	7.45 "	30	3.35 "
28	7.45 "	29	3.35 "	30	7.50 "	31	3.35 "
29	7.45 "	30	3.35 "	31	7.50 "	1	3.35 "
30	7.50 "	31	3.35 "				
31	7.50 "	1	3.35 "				

JUNE, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.50 P.M.	2	3.35 A.M.	1	7.50 P.M.	2	3.35 A.M.
2	7.50 "	3	3.35 "	2	7.50 "	3	3.35 "
3	7.50 "	4	3.35 "	3	10.20 "	4	3.35 "
4	7.50 "	5	3.35 "	4	10.50 "	5	3.35 "
5	7.50 "	6	3.35 "	5	11.20 "	6	3.35 "
6	7.55 "	7	3.35 "	6	11.50 "	7	3.35 "
7	7.55 "	8	3.35 "	7	—	—	—
8	7.55 "	8	12.00 M.	8	12.15 A.M.	8	3.35 A.M.
9	12.40 A.M.	9	3.35 A.M.	9	12.40 "	9	3.35 "
9	7.55 P.M.	9	12.00 M.	10	1.05 "	10	3.35 "
10	7.55 "	10	12.00 "	11	2.30 "	11	3.35 "
11	7.55 "	11	12.00 "	12	No light.	12	No light.
12	7.55 "	12	12.00 "	13	No light.	13	No light.
13	7.55 "	13	12.00 "	14	No light.	14	No light.
14	7.55 "	14	12.00 "	15	7.55 P.M.	15	9.50 P.M.
15	7.55 "	15	12.00 "	16	7.55 "	16	10.50 "
16	7.55 "	16	12.00 "	17	8.00 "	17	11.40 "
17	8.00 "	17	12.00 "	18	8.00 "	19	12.20 "
18	8.00 "	19	12.20 A.M.	19	8.00 "	20	1.00 "
19	8.00 "	20	1.00 "	20	8.00 "	21	1.30 "
20	8.00 "	21	1.30 "	21	8.00 "	22	2.00 "
21	8.00 "	22	2.00 "	22	8.00 "	23	2.25 "
22	8.00 "	23	2.25 "	23	8.00 "	24	2.55 "
23	8.00 "	24	2.55 "	24	8.00 "	25	3.25 "
24	8.00 "	25	3.25 "	25	8.00 "	26	3.30 "
25	8.00 "	26	3.30 "	26	8.00 "	27	3.35 "
26	8.00 "	27	3.35 "	27	8.00 "	28	3.35 "
27	8.00 "	28	3.35 "	28	8.00 "	29	3.35 "
28	8.00 "	29	3.35 "	29	8.00 "	30	3.35 "
29	8.00 "	30	3.35 "	30	8.00 "	1	3.35 "
30	8.00 "	1	3.35 "				

JULY, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light	Date.	Exting.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	2	3.35 A.M.	1	8.00 P.M.	2	3.35 A.M.
2	8.00 "	3	3.35 "	2	8.00 "	3	3.35 "
3	8.00 "	4	3.35 "	3	9.50 "	4	3.35 "
4	8.00 "	5	3.35 "	4	10.20 "	5	3.35 "
5	8.00 "	6	3.35 "	5	10.40 "	6	3.35 "
6	8.00 "	7	3.35 "	6	11.10 "	7	3.35 "
7	8.00 "	8	3.35 "	7	11.35 "	8	3.35 "
8	8.00 "	9	3.35 "	8	—	—	—
9	8.00 "	10	3.35 "	9	12.05 A.M.	9	3.35 A.M.
10	8.00 "	11	3.40 "	10	12.40 "	10	3.40 "
11	8.00 "	11	12.00 M.	11	1.20 "	11	3.40 "
12	8.00 "	12	12.00 "	12	2.10 "	12	3.40 "
13	8.00 "	13	12.00 "	13	No light.	13	No light.
14	8.00 "	14	12.00 "	14	No light.	14	No light.
15	8.00 "	15	12.00 "	15	8.00 P.M.	15	10.20 P.M.
16	8.00 "	16	12.00 "	16	8.00 "	16	10.55 "
17	8.00 "	17	12.00 "	17	8.00 "	17	11.30 "
18	8.00 "	18	12.00 "	18	8.00 "	18	12.00 M.
19	7.55 "	19	12.00 "	19	7.55 "	20	12.25 A.M.
20	7.55 "	21	12.55 A.M.	20	7.55 "	21	12.55 "
21	7.55 "	22	1.25 "	21	7.55 "	22	1.25 "
22	7.55 "	23	2.00 "	22	7.55 "	23	2.00 "
23	7.55 "	24	2.40 "	23	7.55 "	24	2.40 "
24	7.55 "	25	3.20 "	24	7.55 "	25	3.20 "
25	7.55 "	26	3.50 "	25	7.55 "	26	3.50 "
26	7.50 "	27	3.50 "	26	7.50 "	27	3.50 "
27	7.50 "	28	3.50 "	27	7.50 "	28	3.50 "
28	7.50 "	29	3.50 "	28	7.50 "	29	3.50 "
29	7.50 "	30	3.55 "	29	7.50 "	30	3.55 "
30	7.50 "	31	3.55 "	30	7.50 "	31	3.55 "
31	7.45 "	1	3.55 "	31	7.45 "	1	3.55 "

AUGUST, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	2	3.55 A.M.	1	7.45 P.M.	2	3.55 A.M.
2	7.45 "	3	3.55 "	2	7.45 "	3	3.55 "
3	7.45 "	4	4.00 "	3	9.40 "	4	4.00 "
4	7.45 "	5	4.00 "	4	10.05 "	5	4.00 "
5	7.40 "	6	4.00 "	5	10.35 "	6	4.00 "
6	7.40 "	7	4.00 "	6	11.10 "	7	4.00 "
7	7.40 "	8	4.00 "	7	11.55 "	8	4.00 "
8	7.40 "	9	4.00 "	8	—	—	—
9	7.35 "	9	12.00 M.	9	12.50 A.M.	9	4.00 A.M.
10	7.35 "	10	12.00 "	10	1.50 "	10	4.00 "
11	7.35 "	11	12.00 "	11	No light.	11	No light.
12	7.35 "	12	12.00 "	12	No light.	12	No light.
13	7.30 "	13	12.00 "	13	7.30 P.M.	13	9.20 P.M.
14	7.30 "	14	12.00 "	14	7.30 "	14	9.55 "
15	7.30 "	15	12.00 "	15	7.30 "	15	10.30 "
16	7.30 "	16	12.00 "	16	7.30 "	16	10.55 "
17	7.25 "	17	12.00 "	17	7.25 "	17	11.30 "
18	7.25 "	18	12.00 "	18	7.25 "	18	12.00 M.
19	7.25 "	20	12.40 A.M.	19	7.25 "	20	12.40 A.M.
20	7.20 "	21	1.20 "	20	7.20 "	21	1.20 "
21	7.20 "	22	2.05 "	21	7.20 "	22	2.05 "
22	7.20 "	23	2.55 "	22	7.20 "	23	2.55 "
23	7.20 "	24	3.50 "	23	7.20 "	24	3.50 "
24	7.15 "	25	4.20 "	24	7.15 "	25	4.20 "
25	7.15 "	26	4.20 "	25	7.15 "	26	4.20 "
26	7.15 "	27	4.20 "	26	7.15 "	27	4.20 "
27	7.10 "	28	4.20 "	27	7.10 "	28	4.20 "
28	7.10 "	29	4.20 "	28	7.10 "	29	4.20 "
29	7.10 "	30	4.20 "	29	7.10 "	30	4.20 "
30	7.10 "	31	4.25 "	30	7.10 "	31	4.25 "
31	7.05 "	1	4.25 "	31	8.05 "	1	4.25 "

SEPTEMBER, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.05 P.M.	2	4.25 A.M.	1	8.35 P.M.	2	4.25 A.M.
2	7.05 "	3	4.25 "	2	9.10 "	3	4.25 "
3	7.00 "	4	4.25 "	3	9.50 "	4	4.25 "
4	7.00 "	5	4.30 "	4	10.35 "	5	4.30 "
5	7.00 "	6	4.30 "	5	11.30 "	6	4.30 "
6	6.55 "	7	4.30 "	6	—	—	—
7	6.55 "	7	12.00 M.	7	12.40 A.M.	7	4.30 A.M.
8	6.55 "	8	12.00 "	8	1.50 "	8	4.30 "
9	6.50 "	9	12.00 "	9	3.05 "	9	4.35 "
10	6.50 "	10	12.00 "	10	No light.	10	No light.
11	6.50 "	11	12.00 "	11	No light.	11	No light.
12	6.45 "	12	12.00 "	12	6.45 P.M.	12	8.55 P.M.
13	6.45 "	13	12.00 "	13	6.45 "	13	9.25 "
14	6.45 "	14	12.00 "	14	6.45 "	14	10.00 "
15	6.40 "	15	12.00 "	15	6.40 "	15	10.35 "
16	6.40 "	16	12.00 "	16	6.40 "	16	11.15 "
17	6.40 "	17	12.00 "	17	6.40 "	17	12.00 M.
18	6.35 "	19	12.50 A.M.	18	6.35 "	19	12.50 A.M.
19	6.35 "	20	1.45 "	19	6.35 "	20	1.45 "
20	6.35 "	21	2.40 "	20	6.35 "	21	2.40 "
21	6.30 "	22	3.40 "	21	6.30 "	22	3.40 "
22	6.30 "	23	4.40 "	22	6.30 "	23	4.40 "
23	6.30 "	24	4.45 "	23	6.30 "	24	4.45 "
24	6.25 "	25	4.45 "	24	6.25 "	25	4.45 "
25	6.25 "	26	4.50 "	25	6.25 "	26	4.50 "
26	6.25 "	27	4.50 "	26	6.25 "	27	4.50 "
27	6.20 "	28	4.50 "	27	6.20 "	28	4.50 "
28	6.20 "	29	4.50 "	28	6.20 "	29	4.50 "
29	6.20 "	30	4.50 "	29	6.20 "	30	4.50 "
30	6.15 "	1	4.55 "	30	7.45 "	1	4.55 "

OCTOBER, 1908

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.15 P.M.	2	4.55 A.M.	1	8.30 P.M.	2	4.55 A.M.
2	6.15 "	3	4.55 "	2	9.20 "	3	4.55 "
3	6.10 "	4	4.55 "	3	10.20 "	4	4.55 "
4	6.10 "	5	5.00 "	4	11.30 "	5	5.00 "
5	6.10 "	6	5.00 "	5	—	—	—
6	6.05 "	6	12.00 M.	6	12.45 A.M.	6	5.00 A.M.
7	6.05 "	7	12.00 "	7	2.00 "	7	5.00 "
8	6.05 "	8	12.00 "	8	3.15 "	8	5.00 "
9	6.00 "	9	12.00 "	9	No light.	9	No light.
10	6.00 "	10	12.00 "	10	No light.	10	No light.
11	6.00 "	11	12.00 "	11	6.00 P.M.	11	7.50 P.M.
12	6.00 "	12	12.00 "	12	6.00 "	12	8.30 "
13	5.55 "	13	12.00 "	13	5.55 "	13	9.10 "
14	5.55 "	14	12.00 "	14	5.55 "	14	9.50 "
15	5.55 "	15	12.00 "	15	5.55 "	15	10.40 "
16	5.50 "	16	12.00 "	16	5.50 "	16	11.35 "
17	5.50 "	18	12.30 A.M.	17	5.50 "	18	12.30 A.M.
18	5.50 "	19	1.30 "	18	5.50 "	19	1.30 "
19	5.45 "	20	2.30 "	19	5.45 "	20	2.30 "
20	5.45 "	21	3.30 "	20	5.45 "	21	3.30 "
21	5.45 "	22	4.25 "	21	5.45 "	22	4.25 "
22	5.45 "	23	5.15 "	22	5.45 "	23	5.15 "
23	5.40 "	24	5.15 "	23	5.40 "	24	5.15 "
24	5.40 "	25	5.20 "	24	5.40 "	25	5.20 "
25	5.40 "	26	5.20 "	25	5.40 "	26	5.20 "
26	5.35 "	27	5.20 "	26	5.35 "	27	5.20 "
27	5.35 "	28	5.20 "	27	5.35 "	28	5.20 "
28	5.35 "	29	5.20 "	28	5.35 "	29	5.20 "
29	5.35 "	30	5.25 "	29	5.35 "	30	5.25 "
30	5.30 "	31	5.25 "	30	8.15 "	31	5.25 "
31	5.30 "	1	5.25 "	31	9.20 "	1	5.25 "

NOVEMBER, 1908

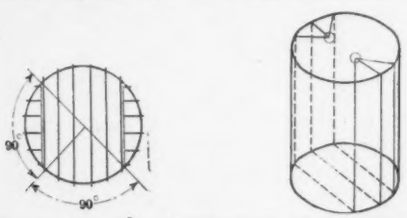
Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.30 P.M.	2	5.25 A.M.	1	10.30 P.M.	2	5.25 A.M.
2	5.30 "	3	5.30 "	2	11.40 "	3	5.30 "
3	5.30 "	3	12.00 M.	3	—	—	—
4	12.

In reception with a closed circuit it is not possible to fix the limiting angle at which reception is possible; this depends at the same time partly on the intensity of the electromagnetic field and partly on the sensitiveness of the detector employed. With increase of either of these factors the angle of reception increases; and under the same conditions of intensity of electromagnetic field and of sensitiveness of the detector, if a detector be employed which is responsive to the maximum amplitude of the oscillations, an angle will be obtained which is greater than that obtained when a detector which responds to the total energy is used.

The diagram of received energy was made in the same way as that of the energy radiated by a closed oscillatory transmitter circuit. The aerial of the receiver station, at a distance of about 2 kilometers from the transmitter, comprised a closed oscillatory circuit similar to the one already referred to. The Duddell thermo-galvanometer was connected to the closed circuit in the manner shown in Fig. 15. On turning the closed circuit around its vertical axis of symmetry the Duddell gave at each position a deflection proportional to the energy received.

The diagram obtained in this manner is practically identical with that of the transmission shown in Fig. 9. As a result, in the case of the reception also, the conclusion can be drawn that the diagram of the electromagnetic field utilized is represented by two tangent circles; and that the diagram of the energy is formed of two tangent curves represented by Fig. 10, and the equation of which is $E = E_0 \cos^2\alpha$.

In wireless telegraphy, in order to allow of as many communications as possible and of the individual independence of the stations, considerable use has been made of syntony. The degree of syntony depends upon the damping of the transmitter



FIGS. 17 AND 18.—DIAGRAMS OF TRANSFORMER.

and receiver systems. In systems employing the vertical antenna and inductive excitation, this value depends chiefly upon the damping of the emitted waves and on that of the receiving antenna; and since in a closed oscillatory circuit the damping is much smaller than with the vertical antenna, so the degree of syntony will be higher when a closed receiver circuit is used in place of the vertical antenna.

The disturbance cause to ordinary radiotelegraphic communication as a result of atmospheric discharges is well known; closed oscillatory circuits are, however, owing to their properties of syntony and directivity, much better protected against atmospheric discharges than is the case with systems using the vertical receiving antenna.

Closed Oscillatory Circuits for both Transmission and Reception.

After having experimented with closed oscillatory circuits separately for the transmission and for reception, a series of tests was carried out between Dieppe, Havre and Barfleur, using exclusively the closed oscillatory circuits both at the transmitting station (Dieppe) and at the receiving stations (Havre and Barfleur).

On suitably orienting the transmitter circuit and regulating the emitted energy, a point was reached where it was possible to send signals at will to either one of these receiving stations without the other one receiving any signals. The reception was quite regular and satisfactory at the two receiving stations, with a maximum of 500 watts employed for transmission.

The results obtained in this way demonstrate that, although the employment of closed oscillatory circuits necessitates the expenditure of a somewhat greater amount of energy than is required with the ordinary systems with vertical antenna, this energy is in no way excessive. It is certainly not exorbitant if the conditions in localities like the English Channel, where wireless telegraph stations are numerous, are taken into consideration.

In these regions, where the adoption of a dirigible system is imperative at present, the ordinary stations use an amount of energy which considerably exceeds what is required. This is done with the object—which each station endeavors to accomplish—of making its own transmission prevail over that of the other stations.

With the employment of closed oscillatory circuits and the same amount of energy the disturbances to radiotelegraphic communication could be, if not entirely eliminated, at least almost completely overcome. The extra energy employed would be compensated in other directions—in the diminution of the damping of the emitted waves and by a syntony much superior to that of the ordinary systems. The experiments made by the authors have demonstrated still further the marked immunity which a closed receiver circuit enjoys as regards transmissions emanating from other stations.

Although in employing the closed circuit at Havre and Barfleur no other signals were received besides those of Dieppe, when the ordinary antenna was used, signals were received from other stations on the English side, or from ships navigating the channel. In the course of these same experiments confirmation was obtained of the great reduction made possible in the effects produced by atmospheric discharges.

Variation of the Direction of Communication.

The system of wireless telegraphy which has just been described presents certain real advantages when it is a question of effecting communication in one invariable direction; but when the direction of communication has to be varied the matter becomes rather complicated from the mechanical point of view. In reality there are two methods which at once suggest themselves as possible means for realizing such a variation. The first method consists in turning the aerial about its axis of symmetry until its plane is in the direction of the desired communication; but this—apart from the mechanical difficulty of such a proceeding—occasions a great loss of time, so that in no case could a good radiotelegraphic service be carried out in this way. The second method is that of equipping the station with several equal circuits, spaced at equal angular distances from one another, and using only that circuit which points in the desired direction. This arrangement, however, necessitates the employment of numerous circuits if a sufficiently close approximation is required; and the presence of several circuits, one close up to the other, may cause trouble as regards the emission of waves. The employment of either of these arrangements thus presents serious inconveniences. It was therefore desirable to find a means of varying the direction of communication which should not require the rotation of the circuit and also not complicate the aerial arrangements at the station.

The solution of the problem has been arrived at by the authors, and consists in the employment of two closed circuits, situated in two vertical planes at 90 deg. to one another, and special apparatus now to be described.

Taking first of all the transmission for consideration: if either one or other of the circuits be excited, the transmission takes place principally in the plane of the circuit so excited. If, however, both circuits be excited simultaneously, the transmission takes place mainly in an intermediate direction, the orientation of which depends upon the intensity and phase relation of the two excitations. As a result, an apparatus which is capable of continuously varying the intensities and phase difference is one which will allow the direction of emission of the waves to be varied.

Several forms of apparatus have been experimented with, but the best results have been obtained with the following: For inductive excitation the apparatus is diagrammatically represented by Fig. 16. An air transformer is provided with two secondary windings at right angles to one another (m_1, n_1), each winding being connected to one of the closed oscillatory

circuits. The primary of the transformer (S_1), internal to the secondaries and joined to a capacity of the spark-gap, is movable on its vertical axis. Owing to this arrangement the excitation of the two circuits depends upon the angle which the plane of the primary winding makes with the planes of the two secondaries; that is to say, with the planes of the two aerial circuits. On turning the primary through 360 deg. the transmission itself is rotated through 360 deg.

In order that the angular displacements of the transformer primary and of the direction of transmission shall always be maintained equal, the transformer has been constructed as indicated in Figs. 17 and 18.

The two secondaries consist each of ten turns of stout wire wound round a cylinder, perpendicular to its ends, of which one is shown in Fig. 17; these windings cover the whole external surface of the cylinder, each one extending over one-quarter of the circumference; the cylinder is hollow internally. The primary is wound around another smaller, coaxial cylinder, perpendicular to its ends in a similar way and also occupying one-quarter of the circumference; at the upper end the windings are radial (for mechanical convenience), those at the lower end diametral. The cylinder is of a size such that it will conveniently go inside the larger cylinder on which the secondaries are wound.

The primary winding consists of a single turn of three wires in parallel, spaced as shown in Fig. 17, and of the same wire as is used for the secondaries.

For direct excitation the arrangement employed is shown in Fig. 19. A continuous spiral is wound on a toroid; four points of this winding, at the extremities of two perpendicular diameters, are connected in a fixed manner to the four extremities of the two aerial circuits. The spark-gap and the capacities (symmetrically arranged) are joined to the two movable contacts on the toroid, maintained invariably at 180 deg. from one another. In shifting the movable contacts the intensities and phases of the excitation of the two circuits are varied, and in consequence the direction of transmission is varied. The two instruments have been used separately for transmitting from Dieppe to either Havre or Barfleur.

Turning now to the reception, the arrangements here are similar to those for the transmission, as is shown diagrammatically in Figs. 20 and 21, where the apparatus (R) for the reception are connected—as in the case of the transmission—to the two closed circuits, which are at 90 deg. to one another.

In considering Fig. 20, the difference between this and Fig. 16 consists in the following: (1) substitution of the detector for the spark-gap; (2) the secondaries of the transformer of Fig. 16 are the primaries of the transformer of Fig. 20; (3) the primary of Fig. 16 is the secondary of Fig. 20. Still dealing with Fig. 20, it can be seen that when the two closed circuits are encountered by the waves emitted by the transmitting station, each primary winding produces a magnetic field of intensity proportional to the e. m. f. of the closed circuit to which it is connected; the resultant field will have the direction perpendicular to the transmitting station. As a result, when the plane of the movable secondary of the transformer is at right angles to the resultant magnetic field, this plane coincides with that of the transmitting station and the reception will be at its maximum; on displacing the movable secondary coil from its position of maximum reception the latter diminishes down to zero. It can be seen, therefore, that by the use of this arrangement it is possible to receive signals whatever the direction of the transmitter; that is to say, it is possible to vary at will the direction from which the reception shall be permitted.

If several transmitting stations are working simultaneously, the receiving station equipped with the apparatus here described will receive the signals from the station with which it wishes to communicate without being troubled by other transmissions. Finally, the position of maximum reception of the movable coil indicates the direction of the transmitting station (the radiant point). In this way and with this apparatus the bearings of quite a number of wireless telegraph stations in the channel have been determined. The practical realization of the receiving apparatus has been effected in following the same principles which have been applied in the transmitting apparatus, so far as the cylindrical surface provided with windings is concerned. A special tuning device for the receiver has been adopted so as to allow of adjustment for different wave-lengths.

The authors only commenced this investigation a short time ago, and for this reason the system is doubtless capable of undergoing further improvement.

Although the experiments were carried out with the aid of provisional apparatus, on account of the modifications continually being introduced, nevertheless the results obtained have been decisive and such as to enable a successful future for the system to be forecasted.

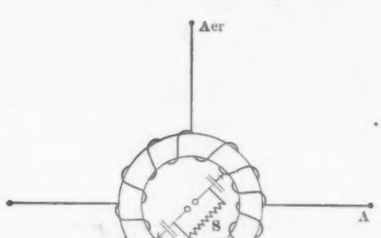
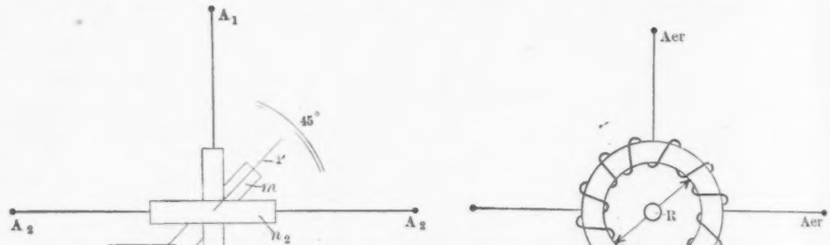


FIG. 19.—ARRANGEMENT FOR DIRECT EXCITATION.



FIGS. 20 AND 21.—DIAGRAMS OF RECEIVING ARRANGEMENTS.

Multiple Wire Windings.

By Charles R. Underhill.

Windings for various electrical purposes often consist of several wires wound simultaneously, the wires forming separate circuits, or with their terminals connected together to act as one conductor. When the wires are grouped as one circular strand, the winding is more effective than when the wires are wound on side by side in the form of a ribbon, owing to the greater pitch in the latter case.

It is well known that, all other things being constant, the winding having the highest efficiency will contain the greater number of turns for a given resistance; but a piece of wire having a given resistance may be so arranged in a corresponding winding space that there will not be one effective turn. The non-inductive resistance coil is one example, but to suit the purpose of this article we will consider an iron core wound longitudinally and uniformly with insulated wire. It is apparent that the turns in this case are not effective for magnetizing the core longitudinally, in the ordinary sense.

In an ideal case the conductor would be at right angles to the longitudinal center of the winding, as in Fig. 1, but in all practical windings, and particularly in the multiple-wire type, there is a tendency of the conductors to incline toward the longitudinal center of the winding. This inclination depends upon the diameter of the turn, the diameter of the insulated

FIG. 1.—IDEAL TURN.

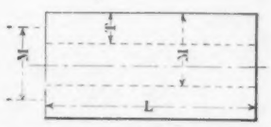


FIG. 2.—DIMENSIONS OF WINDING.

wire, and the number of wires wound simultaneously side by side. It is important always to consider the inclination of the average turn, as the inclination is greater for the inner turns, and less for the outer turns, as compared with the diameter of the turn.

The volume of an ordinary winding in the form of a hollow cylinder may be expressed, $V = \pi MLT$ (1). The dimensions of M, L and T are indicated in Fig. 2. The resistance which

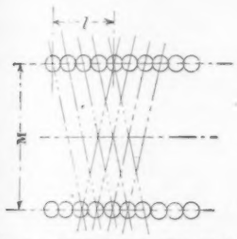


FIG. 3.—FOUR-WIRE WINDING.

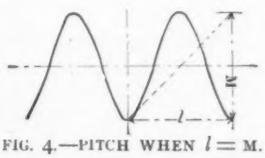


FIG. 4.—PITCH WHEN $l = M$.

may be contained in this winding volume is proportional to the ohms per unit volume for the wire.

In an ideal case the number of turns, N, would be determined by $N = \frac{TL}{g^2}$ (2), where g is the diameter of the insulated wire; but while (2) may hold near enough for many cases in practice, it is important to consider the inclination of the turns, referred to above, when dealing with certain cases. Referring to Fig. 3, the inclination of the turns of a four-wire

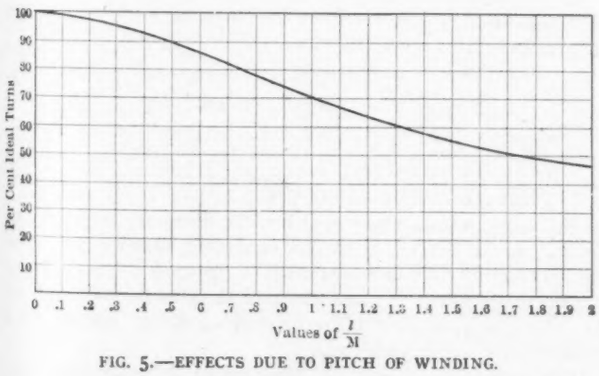


FIG. 5.—EFFECTS DUE TO PITCH OF WINDING.

winding will be appreciated. In this case the number of turns cannot be calculated directly by (2), but the ratio, r, may be determined by $r = \frac{M}{(n^2g^2 + M^2)^{\frac{1}{2}}}$ (3), where n represents the number of wires side by side. Substituting l for $n\,g$, (3) becomes

$$r = \frac{M}{(l^2 + M^2)^{\frac{1}{2}}} \quad (4).$$

(4) also holds for any type of winding.

The number of turns in any winding of this type with any number of wires and with any pitch is

$$N = \frac{\pi TL}{g^2} \quad (5).$$

Substituting the value of (4) in (5),

$$N = \frac{MLT}{g^2(l^2 + M^2)^{\frac{1}{2}}} \quad (6).$$

When $l = M$, the pitch would appear as in Fig. 4. When M is as great as compared with l, the ratio, r, will be near unity, but when l is greater than M, r has a low value. In Fig. 5 is shown the percentage of turns for various ratios of l to M, the resistance remaining constant.

There are other conditions affecting the turns, as, for instance, the imbedding of the wires, but as this is very slight in actual practice, for the smaller sizes of silk and cotton insulated magnet wires, it has been neglected in this article.

The Uniform Illumination of Horizontal Planes.

E. W. May 23.08 page 1107
" " May 30.08 " 1156

BY ALFRED A. WOHLAUER.

IT has been demonstrated in several text-books on illumination (for instance, in "Practical Illumination," by Lansingh and Cravath) that the illumination thrown on a horizontal plane from a light-giving source can be calculated by means of the equation

$$I = \frac{C_p}{h^2}\cos^3 a \quad (1)$$

where

I = foot-candle illumination on surface
h = perpendicular distance, in feet, from lamp to surface
a = angle between ray and perpendicular
C_p = candle-power in a given direction.

For uniform illumination

$$I = I_o$$

a constant value; and, therefore, the equation of the polar curve or the photometric curve for the light-giving body is

$$C_p = \frac{I_o h^2}{\cos^3 a} \quad (2)$$

This gives a curve such as represented in Fig. 1, and as derived recently by E. W. Weinbeer, in *Elektrotechnischer Anzeiger*.*

Thus it follows that in order to obtain a uniform illumination on a horizontal plane with one lamp, it is necessary that the

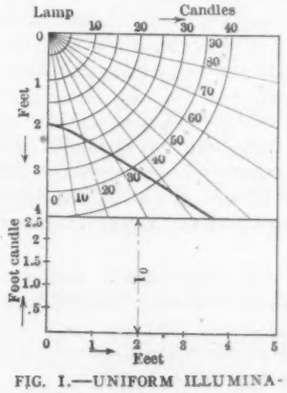


FIG. 1.—UNIFORM ILLUMINATION WITH ONE LAMP.

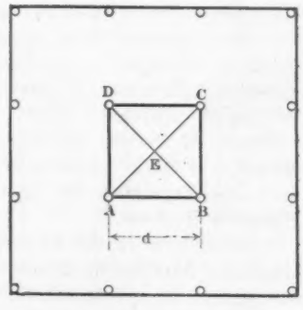


FIG. 2.—HORIZONTAL PLANE TO BE UNIFORMLY ILLUMINATED.

lamp with or without reflector shall have a polar curve of the shape represented in Fig. 1.

Heretofore very little consideration has been paid to these relations in the construction of the lamps or in the design of reflectors. For this reason a coincidence of the above theoretically correct curve with actual lamp curves is merely accidental

*Elektrotechnischer Anzeiger, Nos. 52, 66, 69, 82, 1907. The article in No. 82 was published after this paper was written.

and is realized only for a small angle. This is apparent from the curves published so far, and, in many instances, the use of the reflector destroys the effect which the lamp itself might have produced.

The area of uniform illumination with one lamp is limited, as it is not practicable to design lamps or reflectors so that their polar curves will follow indefinitely the theoretical curve shown in Fig. 1. At some point the curve has to depart from the theoretical course. It is, therefore, impracticable to illuminate uniformly with a single lamp a greater area than one enclosed by an angle of, say, 25 degrees for incandescent lamps and 50 degrees for arc lamps. We can uniformly illuminate, for instance, a table or a desk with one incandescent lamp only when the angle of uniform illumination covers the area of the plane in question.

In order, therefore, to illuminate uniformly larger areas, a number of lamps must be employed and so arranged, and with polar curves of such a shape, as to produce the desired effect. The problem of these relations is discussed in what follows, and for sake of simplicity light reflected from walls and ceiling is neglected.

The area to be illuminated, for instance, a large square horizontal plane, as shown in Fig. 2, may be divided into a number

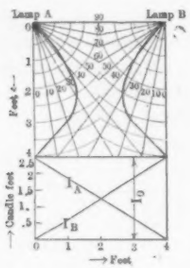


FIG. 3.—UNIFORM ILLUMINATION ALONG THE LINE AB.

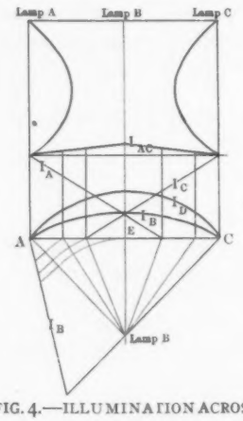


FIG. 4.—ILLUMINATION ACROSS THE DIAGONAL AC.

of squares. At each intersection a lamp is placed at a certain distance above the plane, preferably suspended vertically downward and provided with a reflector. The polar curves of the lamp units will have to be such as to produce a uniform illumination for the whole area.

In order to simplify the matter, at first only the space between two lamps, *A* and *B*, will be considered and the conditions studied existing in a vertical plane through two lamp centers along one side of a square (Fig. 2). The problem thus involved is to illuminate uniformly the line *AB* on the plane by the lamps *A* and *B* above it.

The simplest way of effecting this is indicated in Fig. 3, where the illumination curve of each lamp has its maximum equal to the desired uniform illumination, I_o, just below the lamp and inclines in a straight line to zero just below the other lamp. It is obvious that such a combination gives a uniform illumination along the line *AB*.

If d = distance of lamps,
h = perpendicular distance in feet from lamp to surface or height of suspension,
I_o = desired illumination,
a = angle between ray and perpendicular,
C_p = candle-power in a given direction,

then it can easily be shown that the equation for the illumination curve is

$$I = \frac{I_o}{d}(d - h\tan a) \qquad (3)$$

and according to formula (1)

$$I = \frac{C_p}{h^2}\cos^3 a = \frac{I_o}{d}(d - h\tan a)$$

therefore,

$$C_p = \frac{I_o h^2}{\cos^3 a}\left(\frac{(d - h\tan a)}{d}\right) \qquad (4)$$

the equation for the polar curve of a lamp in the present case.

Such a curve is plotted in Fig. 3 for $h = 4$, $d = 4$, $I_o = 2.5$, and gives a general idea of the simplest form of a polar curve for uniform illumination of horizontal planes with a number of lamps.

The relation

$$\frac{d}{h} = K$$

is of importance and deserves consideration. For reasons of practicability, as previously mentioned, the area of uniform il-

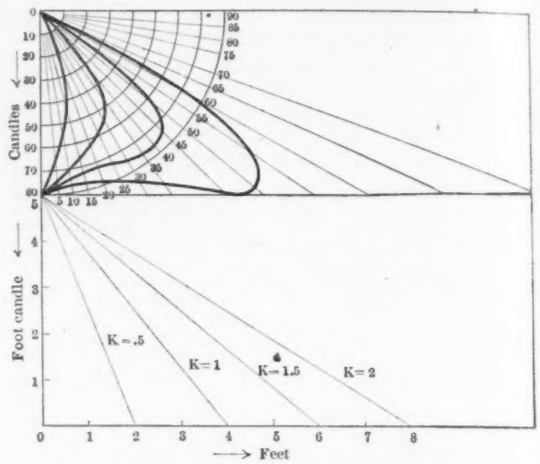
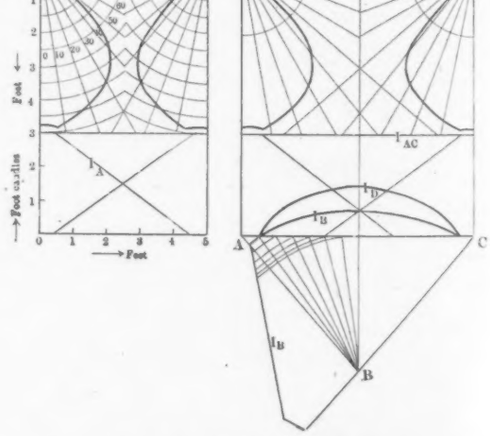


FIG. 5.—SHOWING POLAR CURVES OF LAMPS SUSPENDED EQUALLY HIGH, BUT AT VARYING DISTANCES, YIELDING THE SAME UNIFORM ILLUMINATION.

lumination with one lamp was limited, and similar considerations demand here that the factor K should not exceed values which cannot be realized in practice. Fig. 5 indicates how the polar curves change for different values of K, if I_o and h are constant. In my opinion, a value of $K = 2$ is hardly practicable, and K having a value of about 1.5 may be considered as the limit of practicability.

In engineering problems of illumination, K may be kept constant and d and h varied in the same ratio. Using then the same polar curve, different intensities of illumination can be obtained; or changing the candle-power of the illuminant the



FIGS. 6 AND 7.—PERFECT UNIFORM ILLUMINATION ALONG THE DIAGONAL.

scale of the polar curve must be a different one. However this may be worked out, it is evident that the two lamp units with such polar curves produce a uniform illumination along the line *AB* between the foot of the perpendiculars of the plane; four of them, *A, B, C and D*, uniformly illuminate the outline of the square *ABCD* (Fig. 2).

The point of intersection of the diagonals, *E*, however, would

receive somewhat higher illumination, since the illumination due to one lamp will be at this point

$$\frac{I_E}{4} = .2925\ I_o,$$

as can be easily determined. For uniform illumination, however, this value should be

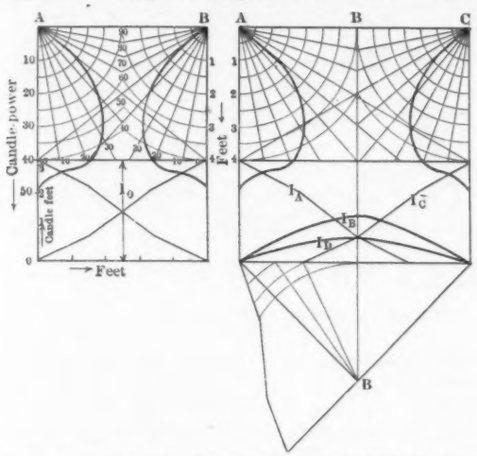
$$\frac{I_E}{4} = .25\ I_o$$

due to the fact that of the total illumination contributed by four lamps, each gives 25 per cent.

The four lamps actually produce an illumination in E

$$I_E = 1.17\ I_o$$

i. e., 17 per cent more than the desired uniform illumination. The illumination along the diagonal AC varies as graphically



FIGS. 8 AND 9.—ANOTHER METHOD FOR UNIFORM ILLUMINATION.

determined and indicated in Fig. 4. The variation is comparatively small and could be neglected in view of the light reflection from the walls and ceiling. It is, however, possible to produce a still more uniform illumination, if the illumination curves due to the light of an individual lamp have a shape as indicated, for instance, in Fig. 6.

In some cases, as, for instance, where a room with low ceiling is to be illuminated, and where the available lamps are of too high a candle-power, it may be necessary, in order to obtain the desired illumination, to place the lamps further apart.

The distance, d, between two lamps may then become so great that the light thrown from one lamp towards the other would not illuminate the area below the next lamp if the factor K is kept within the limits of practicability. In such cases the individual lamp alone must yield uniform illumination for an area just below the lamp, or in other words, the polar curve must conform with the law established above and expressed by equation (2) for an angle corresponding to this area. Beyond that angle the illumination curve may practically again be assumed as inclining in a straight line and passing through zero, where the uniform illumination of the next lamp sets in, as indicated in Fig. 6.

Thus the illumination curve, as well as the polar curve, consists of two parts, the equation of which may be omitted as too complicated for practical use. Such a combination, however, will enable perfect uniform illumination over the whole area.

If we denote

a = the radius of area uniformly illuminated by one lamp,

ϕ = angle for this uniform illumination measured between ray and perpendicular,

then the value

$$a = h\ tan\ \phi$$

subject to the same limitations as discussed above for the uniform illumination with one lamp, must be

$$a = .085d$$

in order to secure the desired illumination I_o at E, the point of intersection of the diagonals.

This can be easily derived mathematically from Fig. 7, which

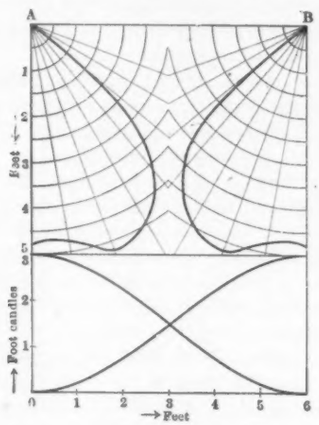
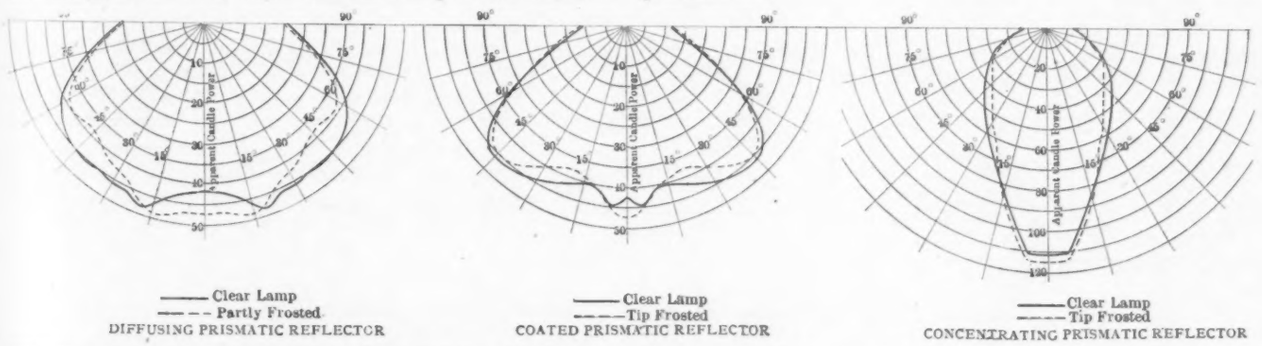


FIG. 10.—GENERAL CASE.

graphically shows that in such a case the illumination is practically uniform over the whole area. The curves I_b and I_d indicate the light thrown from the lamps B and D on the diagonal AC.

It is beyond the scope of this article to discuss in detail these graphical constructions and mathematical determinations as represented, for instance, in Figs. 4 and 7. They could be made the subject of a special paper and are used here only to assist in the proof of the statements.

There are other means to effect uniform illumination, some of which are indicated in Figs. 8, 9 and 14; they are, however, still more complicated, and their equations rather unhandy for practical use.



——— Clear Lamp
– – – Partly Frosted
DIFFUSING PRISMATIC REFLECTOR

——— Clear Lamp
– – – Tip Frosted
COATED PRISMATIC REFLECTOR

——— Clear Lamp
– – – Tip Frosted
CONCENTRATING PRISMATIC REFLECTOR

FIGS. 11, 12 AND 13.—DISTRIBUTION OF LIGHT IN VERTICAL PLANE ABOUT A 40-WATT TUNGSTEN LAMP BACKED BY HOLOPHANE REFLECTORS AND A PRISMATIC REFLECTOR.

The general case of an illumination curve yielding uniform illumination is represented by Fig. 10, which can be expressed by the equation

$$I = I_o \frac{(d-x)}{d} + c \sin \frac{4\pi x}{d} \qquad (5)$$

where d = distance between two lamps

$x = h\ tan\ \phi$ or distance from lamp abscissa

c = a constant to be determined in every individual case, being equal O, if the illumination curve is a straight line.

Substituting, according to Monasch*, for equation (2)

$$C_p = kI_o$$

where

$$k = \frac{h^2}{\cos^3 a}$$

could be exacted from tables made up for this special purpose, the general equation for a polar curve would be

$$C_p = \frac{I_o \kappa (d-x)}{d} + c\kappa \sin \frac{4\pi x}{d} \qquad (6)$$

from which all the possible ways of uniform illumination could be derived.

We have demonstrated that in order to illuminate uniformly large horizontal planes a number of lamps must be employed and their light so distributed that the lamps in their combination produce uniform illumination. The different possibilities have been theoretically discussed and a conception has been formed as to the shape of the polar curves.

It now will be interesting and useful to observe to what an extent the theoretical requirements are fulfilled in practice. To this end a number of tests were made by the Electrical Testing Laboratories under my personal direction.

An up-to-date illuminant, a 40-hefner candle "Just" tungsten lamp, was selected and tested under a number of different conditions, as unfrosted, tip-frosted and entirely frosted, and in connection with a number of reflectors. The same lamp was used for all the tests, the distance from the photometer kept constant, etc., so that the clearest insight into the prevailing conditions was gained.

A few of the results of the tests are reproduced in Figs. 11 to 13. In Figs. 14 to 16 three of these experimental curves are supplemented by curves obtained from theoretical considerations. The experimental curves are in full line, while the theoretical curves are dotted.

The comparison reveals that it is reasonable to expect that uniform illumination of horizontal planes can be realized in practice, in accordance with the laws derived above. The deviations are slight, the greatest occurring at the upper end, which is due to the fact that the illumination curve of one lamp passes through the zero mark where the maximum illumination of the next lamp sets in. This necessitates that the polar curve must return to zero also. In other words, no light should be emitted in the horizontal direction, or in the case of incandescent lamps, reflectors must be used so designed that all the light is utilized below the lamp in accordance with the theoretical requirements discussed above. Therefore, if it is desired to illuminate the upper parts of a room, the lamps must be placed at the proper height.

It is interesting to note further that the distance, d, between two lamps could be made the same in all three cases which have been selected in order to compare theory with practice. It shows that the same number of lamps are used to illuminate the same area, the variation being only in the height of the suspension and in the intensity of illumination. Or, in other words, it is possible in practice also, to vary the intensity of uniform illumination by simply changing the reflectors and the height of suspension. It verifies also the recognized fact that the higher the lamp is suspended above the surface, the less the illumination obtained thereon; concentrating reflectors are required for a higher suspension, while for low-ceiling rooms more diffusing reflectors are necessary.

For high suspension—high being a relative term with regard to the candle-power of the lamp—and for concentrating reflectors, the illumination curve is always a straight line, while for

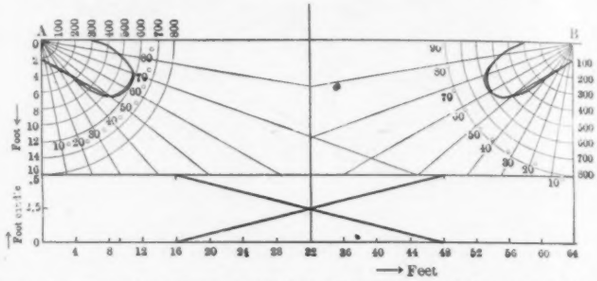
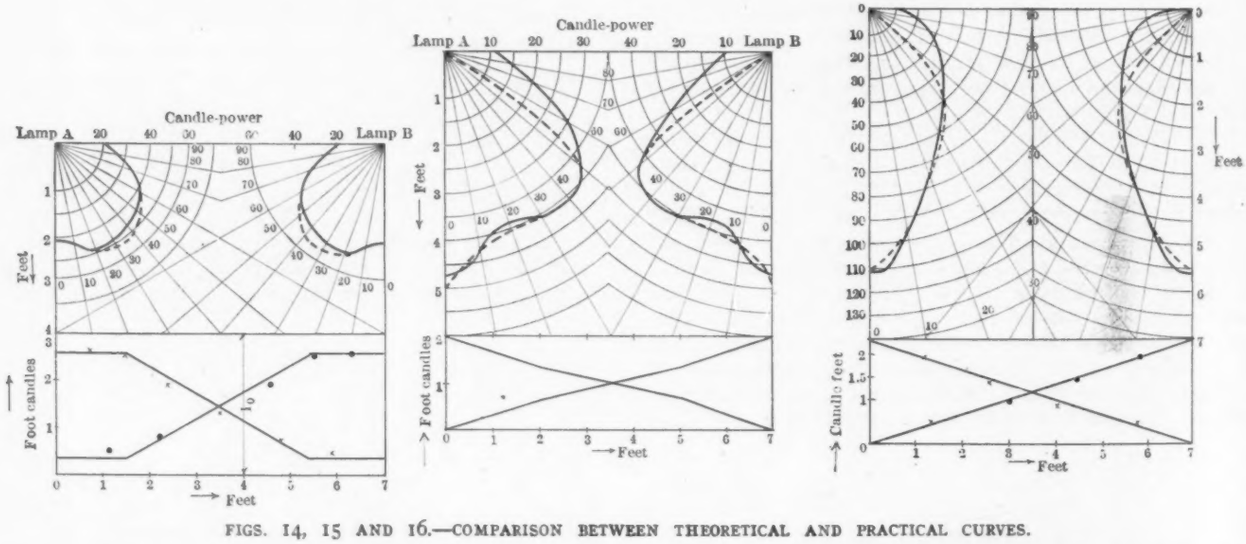


FIG. 17.—UNIFORM ILLUMINATION BY TWO ENCLOSED ARC LAMPS.

rooms with low ceilings one often is compelled to introduce the more complicated illumination curves if small lamp units are not available or too expensive in their total cost.

Otherwise the tests show that it is possible to meet the theoretical requirements with the existing sources of light fairly well. This is demonstrated here for the tungsten lamp; a comparison with other lamps, for instance, Nernst lamps with U-shaped filaments and tantalum lamps, etc., would reveal that the conditions are equally promising.



FIGS. 14, 15 AND 16.—COMPARISON BETWEEN THEORETICAL AND PRACTICAL CURVES.

Of course, the reflectors will play the most important part in realizing the theoretical requirements. Further practical studies are being made along this line in order to effect the desired results in a more systematic way.

In conclusion it will be interesting to call attention to the uniform illumination of very large areas, such as streets, public squares, etc., by arc lamps especially adapted for that purpose. The enclosed arc lamps, for instance, curves of which are shown in Fig. 17, taken from Monasch's book, are not very far from realizing the theory in an ideal way. Fig. 17 shows that with the lamps suspended 20 ft. from the ground and placed 64 ft. apart, an almost ideal uniform illumination will be obtained at a height of 4 ft. above the ground.

*B. Monasch. "Electrische Beleuchtung," 1906.

The Rolling of Thunder.

BY D. S. CARPENTER.

THE rolling of thunder has generally been attributed to the fact that the different portions of the path which the lightning discharge traverses are unequally distant from the point of observation. As the intensity of sound varies inversely as the square of the distance of the source from the observer, and as the various points of the path which become in turn the source of the sound are unequally distant, in the case of a uniform single discharge, the sound would gradually

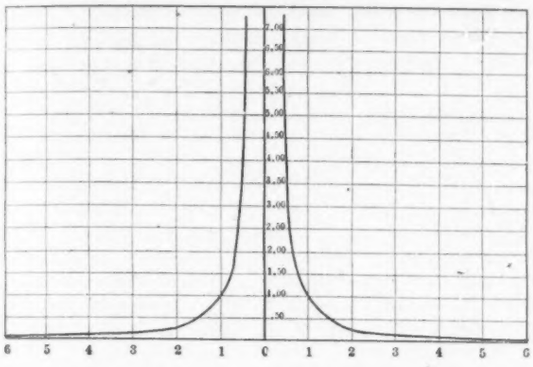


FIG. 1.—LOCUS OF EQUATION $y = \frac{1}{x^2}$

decrease in intensity as the sound waves from the more remote portions of the path of the discharge reach the ear. This view must necessarily require that the transitions be gradual, and that there be none of the extremely abrupt changes in the sound which are so characteristic of thunder. But lately much time has been devoted to the study of the phenomena of lightning, and information has been gained which throws much light on the character of the lightning flash.

Photographs of lightning taken with a moving camera show that the lightning flash is made up of several discharges or rushes which follow one another in quick succession and pass over practically the same path. It is evident that some of these discharges must be of much greater magnitude than others, and that the intervals of time intervening between them must vary greatly in length.

Dr. Waller, of Hamburg, has secured some very interesting photographs of lightning discharges, employing a camera mounted on a vertical axis and rotated at a uniform rate by clockwork. These were taken from a small cabin erected on the roof of a high building. This cabin was provided with windows on all sides, so that an unobstructed view of all parts of the sky was obtained. These photographs show that the lightning flash is composed of several individual discharges. The time intervals between these discharges, calculated from the movements of the apparatus, were very irregular. On his photographs, the first and last discharges appeared to be the brightest. The time intervals between the discharges obtained

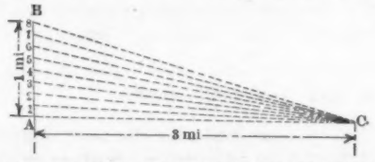


FIG. 2.—RELATIVE POSITIONS OF FLASH AND OBSERVER IN THE CASE OF THE FLASH FROM LINE TO GROUND.

in one flash of six discharges were .131, .068, .075, .119 and .103 seconds, respectively.

Mr. Alex Larsen, of Chicago, has also obtained some very fine photographs of lightning with a moving camera. The "Annual Report of the Smithsonian Institution" for 1905 contains a very good account of his work. His photographs also represent the lightning flash as composed of several separate discharges, as many as 40 being counted in one flash. He estimated the duration of this flash of 40 discharges as .624 second. A marked difference in the magnitude of the individual discharges which compose the flash is clearly shown by all these photographs.

Fig. 2 of the above report illustrates this point. This flash consists of 14 discharges. Two heavy discharges, separated by a short-time interval, occur at the beginning of the flash. These are separated from a third heavy discharge by an interval of about a fourth of a second, during which no discharges are apparent. The remainder of the flash is composed of discharges of much less intensity.

Prof. Trowbridge, of Harvard University, has apparatus

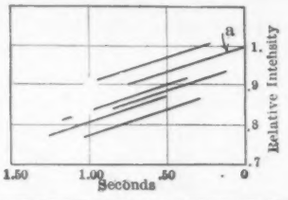


FIG. 3.—RELATIVE INTENSITY AT THE POINT OF OBSERVATION OF THE SOUNDS OF THE INDIVIDUAL DISCHARGES THROUGHOUT THEIR WHOLE EXTENT.

with which he is able to produce a difference of potential of 3,000,000 volts, obtaining sparks 7 ft. long. These sparks exhibit some of the characteristics of lightning discharges. Side discharges and brushes occur at the points where the discharge branches. He has also shown that a phenomenon of an explosive character occurs whenever a powerful spark forks, and concludes that there is an explosion at each point where the lightning discharge forks. It is true that at certain points in its path a phenomenon of the nature of an explosion occurs. The records of the instances where persons have been struck

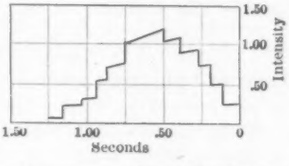


FIG. 4.—INTENSITY OF SOUND OF THE THUNDER AT EACH INSTANT.

by lightning clearly indicate that there is an explosive effect where the discharge leaves the body. Many cases have been recorded where the shoes and stockings have been blown off the feet. It is somewhat difficult to explain this phenomenon. He thinks that these explosions may be one of the causes of the rolling of thunder. It seems probable that the sound of these side discharges and explosions would appear as irregularities only in the sound, and would not be of sufficient magnitude to produce a very great increase in the loudness of the sound,

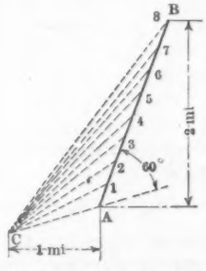


FIG. 5.—RELATIVE POSITIONS OF FLASH AND OBSERVER IN THE FLASH FROM CLOUD TO CLOUD.

except very long branches as to a cloud or to ground, which must be treated as individual discharges in the immediate vicinity of the main discharge.

Tesla has produced sparks said to be 70 ft. in length with Tesla coils, but these discharges have characteristics quite different from lightning.

These researches show that the lightning flash is composed of several discharges. Accepting this view, the rolling of thunder can be explained as follows: If we let y represent the

intensity of the sound and x the distance from the source to the point of observation, the relation between intensity and distance is given by the equation $y = \frac{1}{x^2}$.

For simplicity we will consider the discharge as uniform throughout its length, as variations due to lack of uniformity, forking, etc., in general produce only slight irregularities in the curve representing the relative intensity. This curve is shown in Fig. 1.

The rate of change of the slope is $\frac{d^2y}{dx^2} = \frac{6}{x^4}$. As the distance to the source of the sound increases, this very quickly assumes a very small value. This means that if the flash is

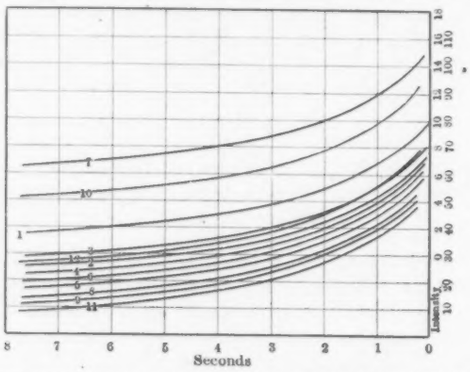


FIG. 6.—RELATIVE INTENSITY AT THE POINT OF OBSERVATION OF THE SOUND OF THE INDIVIDUAL DISCHARGES THROUGHOUT THEIR WHOLE EXTENT.

quite distant, the variation in the distances of the various portions of the path from the point of observation will have little effect upon the intensity and loudness of the sound.

This curve is the locus of the equation $y = \frac{1}{x^2}$. The branch to the left of the axis of ordinates applies to Fig. 2, where the source of sound is represented as to the left of the observer. Where the source of the sound is represented as to the right of the observer, as in Fig. 5, we would use the branch to the right of the axis of ordinates.

Considering all the available data, the probable value of the velocity of sound is 331.7 meters per second at 0 deg. C. The temperature at the time of year during which thunderstorms

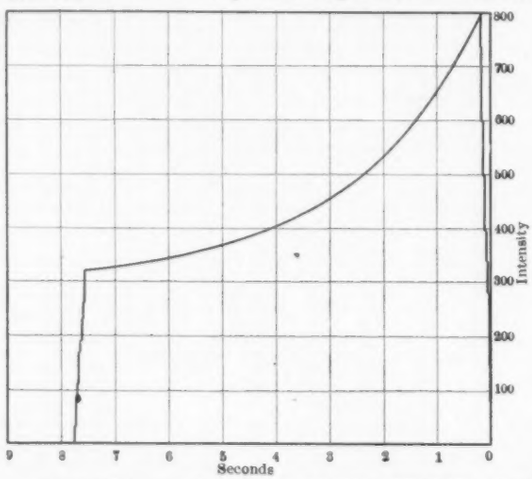


FIG. 7.—INTENSITY OF THE SOUND OF THE THUNDER AT EACH INSTANT.

prevail may be taken as 32 deg. C. Correcting the velocity of sound for this change in temperature by means of the formula

$$S_t = S_0 \sqrt{1 + .003665t}$$

we obtain a velocity of 350.67 meters, or 1150.5 ft. per second.

To develop the theory, we will choose the simplest possible case and assume that the flash takes place from cloud to ground, the discharge being one mile long, and striking the earth three miles from the observer, we would then have the conditions represented in Fig. 2. As the distance of B, the most remote portion of the path, is only .162 mile greater than that of the nearest point, A, assuming the velocity of sound as 1150.5 ft. per second, the report from a single discharge will be only .745 second long. Assuming K as the intensity of the sound from A, and assuming that the discharge is uniform for simplicity, we can easily calculate the relative intensity of the sound from the various points of the path and draw the corresponding curve. The variations due to lack of uniformity, etc., will then be apparent. The discussion of these will be taken up later.

We will let the abscissas represent the time it will require for the sound from the various points to reach the observer at C, after that from A reaches him. Dividing AB into eight equal parts, and making our calculations, we get the values given in Table I. Plotting these values, we get curve a, Fig. 3, for the first discharge of this flash.

For

$$x = -3 \qquad \frac{dy}{dx} = .074 \qquad \Theta_A = 4^\circ\ 14'$$

$$x = -3.162 \qquad \frac{dy}{dx} = .0634 \qquad \Theta_B = 3^\circ\ 38'$$

From this it is seen that there is only 36 minutes between the tangents at the beginning and end of curve a, Fig. 3. So curve a, Fig. 3, will appear as a straight line in the figure.

I.

	Distance Miles	Relative Intensity	Time in Seconds for Sound to Reach C after Sound from A Has Reached It.
CA	3.	1.000 K	.0000 Sec.
C1	3.001	.999 K	.0046 "
C2	3.010	.993 K	.0460 "
C3	3.023	.984 K	.1058 "
C4	3.041	.973 K	.1886 "
C5	3.064	.958 K	.2944 "
C6	3.092	.941 K	.4232 "
C7	3.125	.921 K	.5750 "
C8	3.162	.900 K	.7452 "

We will assume that the flash is composed of six discharges separated by the time intervals given by Dr. Waller, and also that the ordinates of the points at the beginning of the curves represent the relative intensity of the sounds from A for the various discharges. Combining the curves in Fig. 3, we get the curve in Fig. 4.

For a more general case, we will assume the conditions represented in Fig. 5, considering the flash as a discharge from cloud to cloud. The point A is one mile from the observer at C, and the flash, AB, is two miles long. Making our calculations as before, we have Table II.

II.

	Length Miles	Relative Intensity	Time in Seconds for Sound to Reach C after Sound from A Has Reached It.
CA	1.	1.000 K	.000 Sec.
C1	1.145	.763 K	.665 "
C2	1.323	.572 K	1.482 "
C3	1.526	.434 K	2.414 "
C4	1.732	.333 K	3.359 "
C5	1.953	.263 K	4.37 "
C6	2.179	.210 K	5.41 "
C7	2.411	.172 K	6.47 "
C8	2.646	.143 K	7.55 "

The report from a single discharge is 7.55 seconds long.

Assuming that the flash is composed of 12 discharges separated by the time intervals .0338, .0026, .0156, .0130, .0117, .0221, .0078,

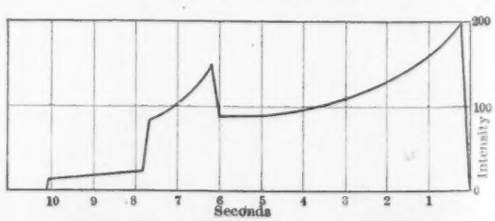


FIG. 8.—INTENSITY OF THE SOUND OF THE THUNDER AT EACH INSTANT WHEN THE SOUND FROM A SECONDARY DISCHARGE IS SUPERIMPOSED UPON THAT OF THE MAIN DISCHARGE.

.0117, .0091, .0065 and .0065 second, and that the ordinates of the points at the beginning of the curves in Fig. 6 represent the relative intensity of the sound from A for the various discharges, we can plot the curves in Fig. 6 for these dis-

charges. Combining these curves we get the curve in Fig. 7.

From the curves in Figs. 4 and 7 we see that the report from a lightning discharge increases in intensity with great rapidity and reaches a maximum value in an extremely short interval of time. It then diminishes very rapidly at first, then gradually, then very rapidly to a zero value. The irregularities occurring in the first and last portions of the curve, where the curves in Fig. 6 begin or end, would probably not be apparent to the ear, except in the case of flashes at a short distance from the observer.

Very often secondary discharges occur, due to the release of charges when the first flash occurs. The sounds from these will reinforce those from the first flash, as the secondary discharges will take place in the vicinity of the first, generally, giving rise to another maximum. In this case the curve would have a second peak, as shown in Fig. 8.

Having given the photograph of a lightning flash with a moving camera, the distance to one end of the flash, its length and relative position with respect to the observer, a curve representing the relative intensity of the report from beginning to end can be drawn, and by getting a record of the report with suitable apparatus at the time of the flash, much light would be thrown on the nature of the flash. Great care would be necessary in recording incidental circumstances.

Torque Analysis of Induction Meters.

BY A. R. DENNINGTON.

Measuring instruments based on the induction principle are extensively used on alternating-current circuits, and a study of the production of the torque is, therefore, not unwarranted.

In the induction type of ammeter and voltmeter use is made of the so-called "shading coil," which is merely a conductor of

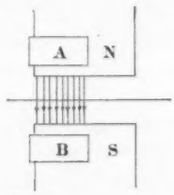


FIG. 1.—INDUCTION AMMETER OR VOLTMETER, FLUX IN AIR GAP.

very low resistance surrounding a part of the cross-section of the magnetic circuit.

In Fig. 1, assume that N and S are the two poles of a magnetic circuit fitted with shading coils, A and B. Consider that the magnetic flux is a maximum in the direction indicated by the arrows and begins decreasing. At the instant the flux is a maximum no current will flow in the shading coils A and B and the density will be nearly uniform all over the pole faces. As the magnetism begins to decrease, a current is induced in the shading coil, which tends to oppose the change and hence to

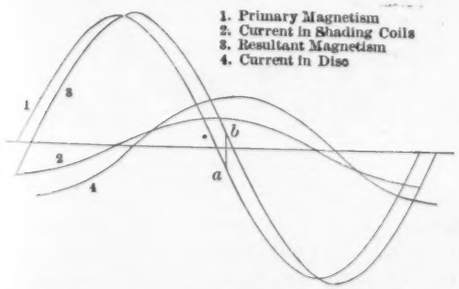
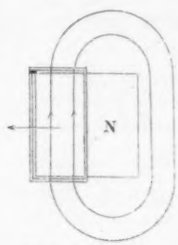


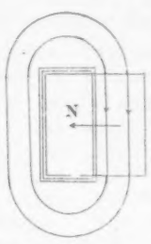
FIG. 2.—CURVES OF MAGNETISMS AND INDUCED CURRENTS.

cause the magnetism included by A and B to lag behind. As the magnetism in the main circuit passes through zero the currents in A and B reach their maximum values, and consequently there is an appreciable flux threading through these coils in the direction indicated. As the magnetism through the main circuit reverses and begins to increase in value in a negative direction, the flux included by A and B decreases and reaches a zero value when the m. m. f. of the exciting coils is great enough to neutralize that of the induced currents in the shading coils. The flux through the shaded section then begins to build up in a negative direction, but this tendency is opposed by the induced currents. At the maximum value of the flux the shading coils have no effect, but the magnetism in the shaded sec-



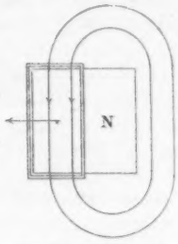
North pole increasing

FIG. 3.—RELATION OF INDUCED CURRENT AND MAGNET POLE, UNSHADED, SECTION INDUCING CURRENT IN DISC.



North pole increasing

FIG. 4.—RELATION OF INDUCED CURRENT AND MAGNET POLE, SHADED SECTION INDUCING CURRENT IN DISC.

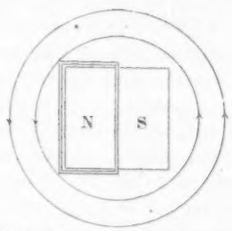


North pole decreasing

FIG. 5.—RELATION OF INDUCED CURRENTS AND MAGNET POLE, UNSHADED SECTION INDUCING CURRENTS IN DISC.

tion reaches a maximum slightly later than in the unshaded portion because of the effect of hysteresis and the magnetizing action of the induced currents building up more rapidly than the magnetism begins to decrease. This is shown in Fig. 2, as are the various curves of magnetism and current.

When the flux in the primary circuit is passing through zero



North decreasing—South increasing

FIG. 6.—RELATION OF INDUCED CURRENTS AND MAGNET POLE. ZERO TORQUE.

in a positive direction, as shown in Fig. 3, that which is affected by the shading coils has a negative value; hence the current in the disc will have a tendency to strengthen the reverse field and react upon it so as to receive a side push in the direction of the arrow. This continues until the magnetism in the shaded portion is reversed and becomes an increasing north pole. The rate of increase in the shaded section will be greater than in the unshaded section for a part of the cycle because the magnetism in the unshaded part is nearer its maximum value, and hence is not on as steep a part of the curve; the conditions shown in Fig. 4 will, therefore, exist, and there will be a thrust in the direction indicated. After the flux reaches its maximum value and begins to decrease, the conditions shown in Fig. 5 will exist.

When the magnetism in the unshaded portion reaches zero

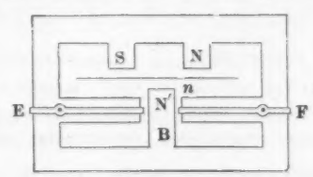


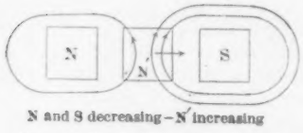
FIG. 7.—MAGNETIC CIRCUIT FOR INDUCTION WATT-HOUR METER.

and begins to reverse, the rate of change is greater than in the shaded portion, the current induced in the disc is a maximum, but the field on which this current reacts is getting near the zero value, and there comes an instant when the rate of charge of the two fields is equal and opposite, $a\,b$, Fig. 2, and at this instant the torque drops to zero. These conditions are

shown in Fig. 6. The torque drops to zero twice in each cycle, but only for an instant.

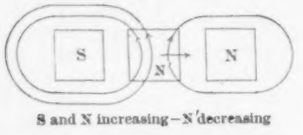
In order to compensate for the increase in permeability, and thus maintain a nearly uniform scale, the inductor is made of a spiral shape. As the magnetic density increases, the radius at which the force acts is shortened and the area of the plate under the pole is reduced so that the resultant torque is made proportional to the current.

In the induction watt-hour meter the shading coils are unnecessary because the flux set up by the pressure coils and that set up by the current coils may be made to differ in phase, and thus give a shifting field.



N and S decreasing—N' increasing

FIG. 8.—RELATION OF INDUCED CURRENTS AND POLES FOR FIRST QUARTER OF CYCLE.



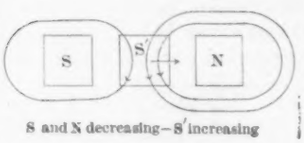
S and N increasing—N' decreasing

FIG. 9.—RELATION OF INDUCED CURRENTS AND POLES FOR SECOND QUARTER OF CYCLE.

Let *N* and *S*, Fig. 7, represent projections on the frame of the meter which carries the current coils. The coils on these projections are wound in opposite directions so that the instantaneous polarities are opposite. The projection *B* is to carry the pressure coil. It will be necessary to secure a magnetism in *B* out of phase with that in *N* and *S* in order to obtain a reaction between the induced currents and the fields to cause a rotation of the disc in a given direction. The pressure coil on *B* will have a high inductance, so the magnetism will lag nearly 90 deg. in time phase behind the pressure across the terminals. This pressure, however, in the main circuit is what causes the current to flow and if the power-factor is unity, the current and magnetism of *N* and *S* will be in phase with the pressure.

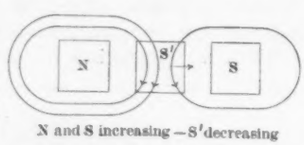
Assume the current in the exciting coils of *N* and *S* to be a maximum and that the power-factor of the circuit is unity. The magnetism in *B* will be changing at its greatest rate, and hence will have its zero value. At this instant there will be currents induced in the disc, due to the pole *B*, and these will react upon the poles *N* and *S* so as to urge the disc toward the right. As the magnetism in *N* and *S* decreases, the flux through *B* will increase, causing a north pole to be formed at *N'*, and this becomes a maximum when the values of *N* and *S* pass through zero. As the current in the exciting coils of *N* and *S* reverses, the value of *N'* decreases and reaches zero when *N* and *S* have reached a maximum in a reverse direction. The action throughout one cycle is given by Figs. 8, 9, 10 and 11. In these figures the eddy currents are shown around the stronger poles only. The flux from the pole set up by the pressure coil will add to the flux to or from that one of the poles due to the series coils which has opposite polarity. The markings of the poles *S* and *N* in Fig. 7 have been reversed in Figs. 8 to 11, inclusive, because the pole *N'* is shown on the same side of the disc as *N* and *S* for the sake of clearness.

Regulation is accomplished by means of one or more permanent magnets which act as magnetic drags by setting up eddy currents in the moving disc. The currents induced are proportional to the speed of the disc and hence, as the field is constant, the retarding force is directly proportional to the speed. There is, however an I^2R loss due to these currents which increases as the square of the speed and this has a tendency to increase the retarding action. The relative effect of friction is reduced for the loads giving a high torque, and this is usually sufficient to counteract the effect of the loss mentioned above.



S and N decreasing—S' increasing

FIG. 10.—RELATION OF INDUCED CURRENTS AND POLES FOR THIRD QUARTER OF CYCLE.



N and S increasing—S' decreasing

FIG. 11.—RELATION OF INDUCED CURRENTS AND POLES FOR FOURTH QUARTER OF CYCLE.

The finer adjustment is usually made by means of coils which may be arranged to include more or less of the magnetic circuit or to have greater or less effect by change in resistance. When a short-circuited coil is placed so as to include the lines of force, it causes the magnetism to lag, and in this manner a perfect adjustment may be made so the meter will register correctly with loads of different power-factors. With non-inductive load, the flux in series and shunt magnetic circuits should differ by 90 deg.

As shown in Figs. 8 to 11, inclusive, the torque on the disc is due to the reactions of the induced currents set up by the series coils on the field set up by the pressure coil. Any variation in current or pressure will, therefore, vary one or both of the urging forces and cause a change in speed proportional to the change in the product of the two fields.

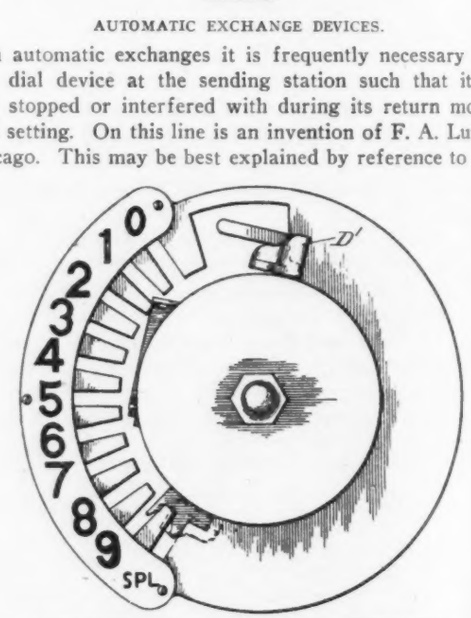
Friction may be compensated for by the use of adjustable shading coils as shown at *E* and *F*, Fig. 7. Changing the position of one of these loops will change the amount and phase of the leakage flux across the air-gap *n*. This will have the same effect as a shading coil on one side of the polar projection and the disc will tend to move toward the loop including the greater number of lines of force.

Increasing the frequency, other things remaining unchanged, will increase the induced currents in the disc, while the magnetic intensity in the poles will be decreased. The net result will be a small tendency for the meter to run too rapidly. As a remedy for this, a copper strip, or damper, may be placed near the disc and moved so it is more or less in the field set up by the eddy currents in the disc. The nearer the damper is to the induced currents the greater will be the retarding effect, because it will act as a secondary of a transformer and will tend to reduce these currents.

New Telephone Patents.

AUTOMATIC EXCHANGE DEVICES.

With automatic exchanges it is frequently necessary to provide a dial device at the sending station such that it is not readily stopped or interfered with during its return movement after a setting. On this line is an invention of F. A. Lundquist, of Chicago. This may be best explained by reference to the cut



LUNDQUIST DIAL FOR AUTOMATIC EXCHANGES.

The fingerpiece *D'* is pulled around until opposite the slot of the desired digit. The fingerpiece is movable and may thus be pushed into the slot. The return motion now begins, and the whole fingerpiece passes out of sight and reach behind the dial plate.

AUTOMATIC RINGING.

In the endeavor to simplify and reduce the operator's work on each connection, a large amount of work has been done on the subject of automatic ringing. With this improvement the operator is relieved of the responsibility of ringing, except

maybe the mere starting of that operation. The ringing current is cut off automatically upon the response of the station. This cut-off is accomplished by a limit relay, which fails to operate under energization by the normal ringing current, but which will operate positively when the ringing current becomes increased, due to the transmitter circuit at the station being cut across the line.

Heretofore the control relay, the coil of which is in the ringing circuit, has always been electromagnetic. It has, therefore, had a reducing effect upon the ringing current. Mr. W. W. Dean has patented a system in which this control relay is non-inductive, the contacts being controlled by the varied expansion of a hot wire in the circuit. The patent for this system is assigned to the Dean Electric Company.

CABLE JUNCTION BOX.

A cable junction box with cable terminal attachment has been patented by Frank B. Cook, of Chicago. The junction box is formed of sheet metal, with a cast mounting bracket. Cable nozzles are secured to the bottom, and the front of the box, which is bolted on, is sealed by a rubber gasket. Splicing may be done within the box, and if it is desired to bring out pairs to a terminal, a plate is removed from its gasket on top of the junction box, thus uncovering a hole. A cable terminal may then be bolted on in lieu of the plate. This terminal is provided with a removable cover to facilitate connection, a rubber gasket serving to seal the terminal.

FUMIGATOR.

L. S. Shrader, of New Albany, Ind., has produced a fumigator for telephone instruments. This consists of a box, with an aperture through which the small end of a transmitter mouthpiece will pass, and with a slot, closed by the lid of the box, in which the receiver shell may be placed. The fumigator is mounted with the instruments in place and disinfectant is burned within it.

TRANSMITTERS AND RECEIVERS.

Mr. H. E. Booth, of Salt Lake City, has made an invention to tone down the sound from a receiver. He extends the cap along the line of the receiver length so as to provide a considerable cavity between the diaphragm and the earpiece. Immediately behind the earpiece in this cavity he places an auxiliary cavity of some porous substance, such as several layers of cloth. This, he says, makes the reproduced tone clearer and protects the ear from any loud reports in the receiver.

The antiseptic idea has taken form as an individual mouthpiece, at the hands of Anna Bebout, of St. Louis. Her invention provides a folding mouthpiece constructed after the manner of collapsing drinking cups, which may be carried in the pocket. This mouthpiece may be inserted in a transmitter by the owner in lieu of the public one.

STEP-BY-STEP SYSTEM.

S. A. Norstrom is also the inventor of a step-by-step party line system, a selecting mechanism being located at each station. The operating magnets are polarized and there is introduced a reversed current arrangement to permit of very quick action of the stepping action.

We now have at hand two later patents bearing on this same system. As usual, there is located an electrochemical device at each station, all of which are to be synchronously manipulated from the central office by current impulses sent over the lines. With this system there is an arrangement for synchronizing the stations at will. To this end, the ratchets are moved by either of two pawls. To synchronize, the ratchets are all advanced to within one step of normal by one pawl and there they stop, as the tooth corresponding to the next step is omitted. It is to be understood that enough impulses are sent out to insure the position of the ratchets at the dead point. One step by the second pawl then advances all to normal.

TELEPHONE SET.

A telephone wall set has been patented by W. W. Dean in which all working parts to be included in the box are mounted together as a self-contained mechanism. This comprises a metal shelf, supporting the bells, ringer mechanism, coil, hook switch, etc. This shelf is to be screwed to the backboard, and the box swings up to cover it and provide a writing shelf, the metal shelf above mentioned serving as the bottom of the box. The completed set has the appearance of the usual standard wall set. Mr. Dean has assigned his patent to the Kellogg Switchboard & Supply Company.

LETTER TO THE EDITORS.

Calibration of Polyphase Wattmeters and Watt-Hour Meters.

To the Editors of Electrical World:

SIRS:—Referring to the communication from Mr. Frederic Lange, on the subject of switchboard instruments, in your issue for Dec. 7, page 1115, I note that he raises again the ghost of the long-dead contention that two single-phase independent wattmeters on a polyphase circuit are easier to calibrate than a polyphase meter.

Besides the increased accuracy and convenience obtained by using a polyphase meter on a polyphase circuit, it will be found that one polyphase meter can be calibrated just as quickly as two single-phase meters, if not more quickly. In calibrating polyphase wattmeters or watt-hour meters it is not necessary to use a polyphase circuit. A single-phase circuit is sufficient, connecting the shunt circuits of the meters in parallel, and the series circuits in series, then proceeding as for single-phase meters.

For various other reasons against using a single-phase meter on polyphase circuits, I beg to refer to an article of mine on page 536 of the ELECTRICAL WORLD for Sept. 14, 1907.

PITTSBURG, PA. PAUL MACGAHAN.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

Interpole Machines.—A. ROTHERT.—An article in which the author distinguishes between such cases in which the commutation of direct-current machines is intended to be improved somewhat by interpoles, and the more serious cases in which good commutation becomes possible only by the introduction of interpoles. In the latter case the machine, should be designed at once as a perfect interpole machine, while in the former case it is possible to add interpoles simply to existing machines without further changes of the design.—*Elek. Zeit.*, Nov. 14.

Interpole Machines.—E. SCHULZ.—An article in which the author shows that construction of direct-current machines with a number of interpoles one-half that of the real poles, reduces the extra cost by more than one-half, and that for this reason this method is specially suitable for smaller machines. The author refers to the heating of the interpole winding and gives a numerical example.—*Elek. Zeit.*, Nov. 28.

Lamps and Lighting.

Flame Arc Lamp.—An illustrated article on the Blondel flame arc lamp which has been in use for some time in Continental Europe and which is also made now on a commercial scale in

England. The carbons used are heavily mineralized, and give a long and curious-shaped flame of great intensity, emitting light of a pale yellow or primrose color, which is most pleasant to the eye. The color is a mean between the orange-colored light given by most of the inclined-carbon lamps and the white light of the ordinary arc. Fig. 1 gives the curve of candle-power distribution for this lamp, also for an ordinary white arc lamp and an inclined-carbon flame lamp. The high candle-

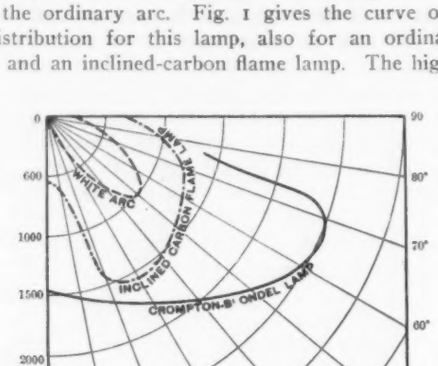


FIG. 1.—CANDLE-POWER DISTRIBUTION OF FLAME ARC LAMP.

power of the new lamp, in directions near to the horizontal line, is of value for lighting streets, open spaces, factories, buildings, etc., where it is advisable to have an even distribution of light.—Lond. *Elec. Eng'ing*, Nov. 28.

Tantalum Lamp.—L. H. Walter.—The General Electric Company of this country has developed a process for increasing the resistivity of tantalum for the purpose of producing a high-voltage tantalum lamp. If the filament is heated, by passing a current through it for 15 minutes in an atmosphere of nitrogen at a pressure of 15 millimeters of mercury the resistivity is increased about four times the original value, and reaches about 44 microhms per centimeter cube. The author has applied this method to the filament of an ordinary tantalum lamp. While he confirms the rise of resistivity, he finds that the mechanical properties of the filament are also changed; the formerly ductile, strong, flexible and springy filament now becomes exceedingly brittle and the tensile strength is very low. The author thinks that there is some promise in the proposition of Siemens & Halske to employ a tantalum filament in series with a carbon filament (preferably graphitized carbon) in the same globe. A high-resistance lamp is thereby obtained with only a short length of metal wire, and the efficiency is good. Moreover, the combination of positive and negative temperature coefficients results in the lamp taking practically the same current when hot and when cold.—Lond. *Electrician*, Nov. 22.

Measuring Vacuum.—G. Berndt.—An illustrated description of an instrument for measuring the degree of a vacuum. It is said to be suitable, for instance, in the manufacture of incandescent lamps. It is based on the principle that the temperature of a wire which is supplied with a constant quantity of heat per

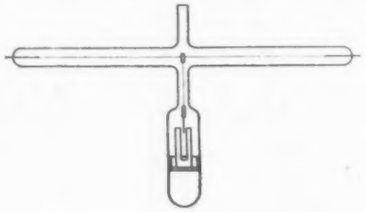


FIG. 2.—MEASURING VACUUM.

unit of time increases with increasing vacuum, because the loss of heat by conduction decreases. The best arrangement is to heat the wire by passing an electric current through it. The instrument is shown in Fig. 2, the silver wire being stretched along a tube and loaded in its center with a copper or aluminum disc which is suspended between the poles of a permanent horse-shoe magnet so as to provide an excellent electromagnetic damping. If constant current is sent through the wire, the temperature of the wire will depend on the vacuum and according to the temperature the sag of the wire will vary. This action was observed by means of a microscope.—*Elek. Zeit.*, Nov. 21.

Metallic-Filament Lamps.—Niethammer.—In using metallic-filament lamps the author has found that quick, small variations of the supply voltage, amounting to one or two per cent or less, are more easily perceptible to the eye in the case of metallic-filament lamps than in the case of carbon-filament lamps, especially with alternating-current networks without storage batteries. This is due to the thinness of the filaments and their small heat inertia. Metallic filaments follow the variations of current far more quickly than carbon filaments, and the author doubts whether it is possible to operate metallic-filament lamps at a frequency of 25 without causing a disagreeable flicker.—*Elek. und Masch.*, Nov. 25.

Nernst Lamp.—In a paper by J. Koenigsberger on the conduction of electricity in solid bodies and the electronic theory, the question of the nature of the conduction in the Nernst lamp filaments is touched upon. The opinion is expressed that the conduction is not of a purely electrolytic nature. In the discussion which followed, Nernst said that at temperatures of 1400 to 1500 deg. C. the conduction is without doubt distinctly of an electroyltic nature, as can be shown experimentally. But at higher temperatures, such as 2000 deg. C., electrolytic conductivity becomes of less importance and amounts to perhaps only one per cent of the total conductivity. At such high temperatures the peculiar observation is made that the nature of the oxides is of small importance; above 2000 deg. C. all oxides or mixtures of oxides have approximately the same conductivity. This fact also indicates that the conduction is not purely electrolytic at such high temperatures.—*Phys. Zeit.*, Nov. 15.

Power.

Electric Air Drill.—W. L. Saunders.—His full illustrated paper presented before the American Institute of Mining Engineers on a new electric air drill and its advantages. The most surprising revelation of all in connection with this electric air drill is "the now indisputable fact that it takes only from one-third to one-fourth of the power, at the power house, to drive it to do the same work as a simple pneumatic drill. This is accounted for by the fact that the same air is used over and over, and that all of its elastic force is availed of in both directions instead of exhausting the charge for each stroke at full pressure. There are also no large clearance-spaces to fill anew at each stroke, as these spaces are never emptied. A valuable feature of the electric air drill, is the ability to yank the bit free if stuck in a hole and immediately continue its work. When the bit of the ordinary air or steam drill sticks in the hole, the drill stops and the drill runner must free the bit as best he can. Ordinarily the feed is run up and down, the drill is hammered and things are coaxed in various ways until the bit is free. When the bit of the electric air drill sticks, the motor and the pulsator pistons do not stop." At Idaho Springs, Col., a mine shaft was put down 67 ft. in 24 shifts and the total energy cost was $24.00 for the entire work. —*Bi-Monthly Bulletin of the Am. Inst. Mining Engineers*, November.

Electric Energy in Steel Works.—E. J. Brunswick.—An article on the electric driving of rolling mills, on the basis of a report of Geyer.—*L'Industrie Electrique*, Nov. 25.

Steam Turbine.—J. Zwonicek.—An illustrated description of his type of steam turbine.—*Elek. und Masch.*, Nov. 24.

Traction.

Rail Corrugations.—A. T. Arnall.—An article on the cause of corrugations on tram rails. On a curve the outer rails have to cover a greater distance than the inner rails. The friction will be a mixture of rolling and sliding. On the outer rail there is rolling friction only, yet modified in the following way. The rolling body produces a deformation of the surfaces in contact, and a certain sliding friction is set up between them, as they recover their original forms. Mathematical analysis shows

that if the speed of the wheel exceeds a certain critical velocity, the wheel must be free from contact with the rail for certain intervals of time. If this is admitted, it is evident that as a car rounds a curve there are all of the elements necessary for a torsional vibration of the wheels and axles. The drag on the inner wheel forced by the slip twists the axle against the frictional resistance caused by the wheel which does not slip. The loose contact gives frequent opportunities for the wheel to free itself, and the wheel flies backwards, to be caught up again, resuming contact with the rail. By "backwards" is here meant the direction opposite to the rolling motion; it, therefore, gives a forward push to the metal displaced on the rail surface. "The action of the wheel may be very closely imitated by pressing the end of the middle finger in a nearly vertical position on the table and pushing it stiffly forward. In general it will not slide, but progresses in a series of little jumps. The outer wheel of a tram car on a curve moves in the same way. There is a rolling motion in addition, but it does not interfere with the vibration due to the rubbing and twisting of the axle. It has the effect of spreading out the corrugations, and bringing fresh parts of the wheel into contact." The only part of the car having any influence on the result is the piece of axle clear between the wheels. It is useless to attempt to stop the vibrations, since they arise from mechanical conditions which are practically beyond control, but the desired end could be attained if their effects on the rail did not accumulate. Probably a sufficient variation in pitch would be produced by a small increase or reduction in the diameter of one axle on every car, or it might be necessary to use axles of three or four different diameters. Further investigation is necessary before the precise value of the axle diameter on the corrugations can be determined, but it is believed that a fuller knowledge of the influence of this factor in the problem will lead to a remedy being found for the present costly and troublesome nuisance.—Lond. *Electrical Engineer,* Nov. 29.

Electric Traction.—H. S. KNOWLTON.—An article of a general nature on organization problems in the electrical equipment of a steam railroad.—*Eng'ing Magazine,* December.

Wires, Wiring and Conduits.

Graded Cables.—The paper by A. Russell, which was abstracted in the Digest last week, elicited a very extended discussion. Prof. J. A. Fleming, who opened it, stated that compressed air might be used as a dielectric even for cables; its dielectric strength increases approximately in proportion to the pressure, so that at 14 atmospheres it compares with oil as a dielectric. He also gave some interesting comparisons of the size of dielectrics for storing the same amount of energy and called attention to the falling off of dielectric strength of materials after prolonged use. Mr. Nisbett of the British Insulated & Helsby Cables, Ltd., criticized Mr. Russell's premises, and doubted his conclusions. Since receiving a proof of the paper he had insulated a 7/16 and 37/16 cables with the same number of papers, and covered the insulation with copper foil. The 7/16 cable broke down at 53,000 volts, and the 37/16 at 37,000 as a mean of several tests. This pointed to exactly the opposite conclusion to that of Russell and Jona. He could make with paper insulation a cheaper cable than the Jona's graded cable, and it would withstand the same tests. He also pointed out the necessity of testing cable at a voltage at least sufficiently high to pierce a layer of air the same thickness as the dielectric. Mr. W. H. Patchell referred to some successful experience in the United States with a 20,000-volt cable, in which varnished cambric was used between the copper and paper insulation. Mr. O'Gorman defended the graded cable. He had checked Mr. Russell's mathematics and found them correct, but he raised the point whether it is safe to assume that the strain is proportional to the stress in a cable dielectric. His remarks included a vehement attack on British cable-makers for neglecting the graded cable. Mr. Archibald Campbell and Mr. C. C. Paterson, both of the National Physical Laboratory, suggested alternative methods for measuring the dielectric strength of solids. Mr. C. P. Sparks, engineer-in-chief of the County of London Electric Supply Company, gave some of his experiences with rubber-insulated cables, and said that it was wrong to suggest that cable-makers are people without enterprise or scientific knowledge. From his dealings with them he knew they spend much time and money in developing improvements, and he believed that the British firms continue to be the leaders of the cable industry. Four communications with regard to the paper were received. Mr. E. Jona described an experiment which showed that the partial breaking down of a dielectric does not take place when, theoretically, it should occur, and gives as his experience that theories based solely on the potential gradient are "deficient," representing the partial truth only. Mr. F. J. Howe had employed graded cable with success for the leads from the high-voltage transformers to the test tanks at Johnson & Phillips' works. It is used at a pressure up to 50,000 and occasionally 70,000 volts and its dimensions, which are given in detail, correspond closely with Mr. Russell's formulæ. Dr. C. C. Garrard, of Ferranti, Ltd., has had trouble with fine high-tension fuses, which he attributed to electrostatic discharge, owing to the small diameter and consequent high potential gradient. Prof. J. T. Morris suggested as a substitute for graded cable the insertion of thin conducting layers dividing up the dielectric into two or three equal parts, and the connection of these conductors to tappings from the transformer supplying energy to the cable, so as to keep these sheaths at the desired intermediate potential.—Lond. *Electrical Eng'ing,* Nov. 21.

Aluminum for Conductors.—J. B. SPARKS.—An illustrated article on aluminum as a substitute for copper for electrical energy transmission purposes. The author shows that aluminum may be expected to compete very favorably with copper for use in low-tension cables. But for use in high-tension three-core cables the price of copper would have to be abnormally high or the price of aluminum abnormally low in order that the aluminum cables could show any advantage. It is also shown that aluminum has every chance of becoming even more widely used than copper for overhead work. The author finds that for equal conductivities and for such prices of the two metals as cause the conductors, for equal conductivities, to cost the same (that is, when the price per ton of aluminum wire is just double the price of copper wire), an aluminum overhead line will cost about the same as a copper line. If aluminum is cheaper than copper for equal conductivity, an aluminum line will generally be the more economical.—Lond. *Electrical Review,* Nov. 15 and 22.

Insulation.—HILLS AND GERMANN.—An article giving some notes on insulation and insulation testing, with respect to line insulation, oils, varnishes, ageing and heating, and marble.—Lond. *Elec. Engineer,* Nov. 8.

Fuses.—R. HUNDHAUSEN.—An illustrated article on standardization of fuses by means of special apparatus.—*Elek. Zeit.,* Nov. 21.

Electrophysics and Magnetism.

Resonance in Alternating-Current Circuits.—F. GRUNENBAUM.—A mathematical article in which the author shows that the simple condition for voltage and current resonance, namely $LC\omega^2 = 1$ (L being the self inductance, C the capacity and $\omega = 2\pi$ times the frequency), is valid only if the alternating-current circuit contains no iron. It ceases to be valid if the self-inductance coil surrounds iron or if it has an appreciable resistance. The resonance condition is different according to whether the self-inductance or the capacity is regulated. The author speaks of "relative resonance." The conditions for the different cases are mathematically formulated and the results are confirmed by measurements.—*Elek. Zeit.,* Nov. 21, 28.

Electrochemistry and Batteries.

Nitric Acid From Air.—J. MOSCICKI.—An illustrated article on his work in the fixation of atmospheric nitrogen by means of electric discharges. He first used the method of high-frequency discharges which were produced by a special system of inductance coils and condensers. On account of the high first cost this system was unsuccessful, and the author then undertook to develop a new system in which an arc is used which is magnetically deviated. The arc is produced between

two concentric carbon rings which act as electrodes. By means of a magnetic field perpendicular to the plane of the rings the arc is deflected and is caused to rotate within the annular space between the two rings. This system is said to be quite successful, a yield of 525 kg. of nitric acid being obtained per kw-year. The method, however, has not yet been introduced to industrial scale. The same method was also used in experiments of Brion, while the Badische Anilin und Soda Fabrik uses a quiet continuous arc several meters in length enclosed within a tube of suitable diameter, the air being passed through the tube from one end to the other. The specific yield of nitric acid is stated to be higher with this arrangement than with the Birkeland-Eyde process.—*Electrochemical and Met. Ind.*, December.

Electric Smelting of Copper Ore.—J. W. Richards.—The great bulk of all copper ores are sulphide ores, and in many cases the sulphur and iron present are sufficient heat producers to allow of the smelting of the ore simply by the aid of their oxidation, which is the principle of pyritic smelting. The only field for electric furnace processes appears to be in the smelting down of ores carrying too little sulphur and which require, as usually treated, the use of carbonaceous fuel to assist fusion. Whenever such fuel is expensive, and electric power may be obtained at a low price, an electric-furnace process may be possible and profitable. Such conditions may easily occur in the vicinity of copper mines where large water powers are available. The author gives an example of the treatment of Chilean copper ore and shows that in case of very cheap electric energy great savings are possible in some localities by using the electric furnace, valuable ferrosilicon being obtained as a by-product of the process.—*Electrochemical and Met. Ind.*, December.

Electric Traction in Spain.—The Railroad Company of Southern Spain will introduce electric traction on a portion of 22 kilometers length on a single-track line from Linares to Almeria, the total length of which is 230 kilometers. Five electric locomotives are to be used. This line has a uniform grade of 2.75 per cent and the steam locomotives are too slow in ascending this grade. Three-phase current will be used, the transmission voltage being 5500. Each locomotive is rated at 230 kw, and two locomotives will be used per train.—*L'Industrie Electrique*, Nov. 25.

Rapid Electro-Analysis.—F. C. Fray.—For rapid electro-analysis thorough stirring and circulation of the electrolyte is important. For this reason one or both electrodes are usually rotated. The author obtains the same result without rotating any electrode by using two concentric cylinders as electrodes and producing a magnetic field perpendicular to the electric lines of force. This is done by a solenoid wound around the cell, the same current producing the magnetic field and the electrolytic action. Under these circumstances the electrolyte will be set into rapid rotation.—*Jour. Am. Chem. Soc.*, Nov.

Galvanizing.—A. Sang.—A paper on old and new methods of galvanizing, discussing the familiar methods of hot galvanizing and electroplating, with remarks on pickling. The chief part of the paper is devoted to description of the "sherardizing" process of Cowper-Coles.—*Proceedings Engineers Soc. of Western Penna.*, November.

Induction Furnace.—V. Englehardt.—The conclusion of his long and profusely illustrated paper on the electric induction furnace and its application in the iron and steel industry. The author discusses in detail the development of the Kjellin furnace and of the Roechling-Roednhauser furnace.—*Elektrotechnische Zeitschrift*, Nov. 14, 21.

Units, Measurements and Instruments.

Photometer.—A description of a new selenium photometer of German make, in which a selenium cell is alternately illuminated by the standard lamp and by the lamp under test. The arrangement is shown in Fig. 3, where *S* is the selenium cell which is given an oscillating movement so as to pass directly from the illumination from the lamp *i* to the illumination from the lamp *I*. Both *i* and *I* are fixed on the photometer bench, while *b* and *c* the two mirrors which reflect the rays of the two lamps in the same direction, so that the oscillating selenium cell is successively lighted by the two lamps. The selenium cell *S* is in series with a battery and a galvanometer. If the two illuminations are equal the current in the circuit is constant and the needle of the galvanometer remains at rest. If the two illuminations are unequal, the needle vibrates. By moving the photometer box or one of the lamps a balance is obtained in the ordinary way. The galvanometer is calibrated to 6 milliamperes, but only the values between 4 and 6 or 5 and 6 are

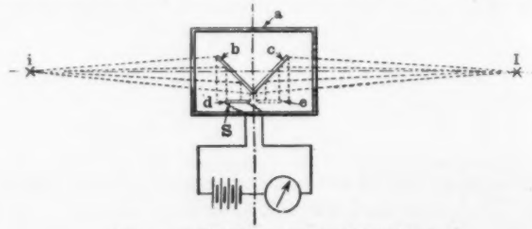


FIG. 3.—DIAGRAM OF PHOTOMETER.

marked on the scale. The greater part of the scale is suppressed and it is said that the measurements are thereby rendered more accurate. If a zero method is preferred to a deflection method, the selenium cell may be connected in series with the battery and the primary of a transformer, whose secondary winding is connected to an alternating-current galvanometer.—Lond. *Electrician*, Nov. 22.

Photometry.—M. Lauriol.—A paper presented before the International Photometric Committee in Zurich on the photometry of sources of light of different colors. The author recommends the use of a prism of gypsum or porcelain, the sharp edge of which is opposite to the observer. The two sides are illuminated by the two sources of light, without using any mirrors, lenses, etc. It is thought that in this way many sources of error due to the action of the light on the retina of the observer are eliminated, and it is recommended that a photometer based on this principle should be carefully studied. It is believed that when measured in this way, the law holds true, that if two sources of light are equal to a third one, they are also equal themselves, but this rule needs further confirmation by experiment. It would be important to find a standard which in its color is as nearly equal to sunlight as possible.—*Zeit. f. Beleucht.*, Nov. 10.

Alternating-Current Watt-Hour Meter.—An illustrated description of an alternating-current watt-hour meter of British make. It is of the induction type, the moving part being an aluminum disc. The special feature of the instrument is a magneto vibrating footstep-bearing to reduce friction to a minimum. It is shown in Fig. 4. When an alternating current is in the coil *U*, the armature *J*, being in an alternating mag-

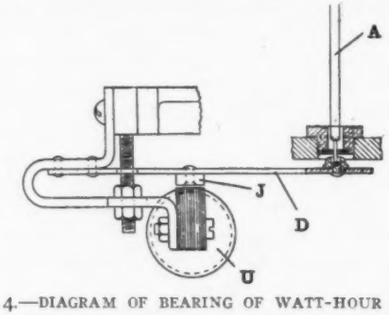


FIG. 4.—DIAGRAM OF BEARING OF WATT-HOUR METER.

netic field, will vibrate. This vibration is communicated to the flat spring *D*, and thence to the jewel bearing and spindle *A*. The action is similar to tapping an instrument to get the highest accuracy of the reading. By this means the meter is enabled to start with a very small current, and the friction is reduced to a minimum, so that the readings will be extremely accurate on light load.—Lond. *Electrician*, Nov. 22.

Induction Meters.—R. Ziegenberg.—An illustrated article on induction meters and the principle of their operation, with descriptions of various recent constructions.—*Zeit. f. Beleucht.*, Oct. 20 and Nov. 20.

Electrical Equipment of the Stuyvesant Theater, New York City.

One of the most complete electrical equipments ever built for a modern playhouse has been installed in the Stuyvesant Theater, New York. The interior illumination is most restful and pleasing, and much of the artistic treatment has been produced in accordance with suggestions from Mr. Belasco, who has a reputation as a most particular manager in the production of plays and in the acquisition of proper lighting and dramatic effects.

The stage is equipped with 84 arc and incandescent pockets, each of which is rated at 50 amperes. The pockets are placed

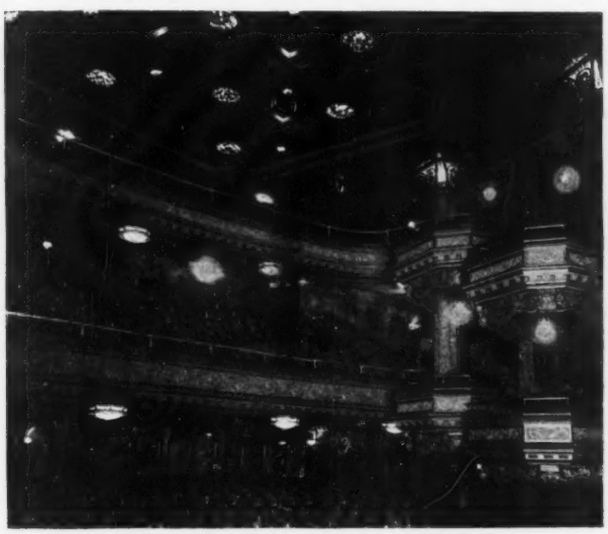


FIG. 1.—INTERIOR VIEW OF STUYVESANT THEATER FROM STAGE.

in the stage floor and in the floor of the spot-light gallery, erected for this particular purpose.

The entire lighting is controlled from a back-connected theater switchboard, of modern construction, all switches being controlled individually, collectively, or in any combination desired at will. The board is made of highly polished Monson slate, with the various operating levers, gang shafts and sectional shafts mounted thereon. It is supported on a heavy, angle-iron frame about 2 ft. from the proscenium wall on the lighting bridge. The switchboard floor consists of a large slab of white marble, and is approximately 12 ft. from the floor.

The dimmer handles and shafts are mounted directly above the board and can be manipulated similar to the switchboard section. The dimmers, which are of the well-known Ward Leonard type, are mounted above the stage switchboard, and are operated by means of steel rod drives.

A junction box is installed directly underneath the marble switchboard floor. It is divided into sections and provided with large doors for the purpose of easily getting at the wiring. The wires in this box are tagged and numbered for convenience in making repairs quickly. The center of distribution for the auditorium and stage lamps is located underneath this junction box, so that should a fuse in any section or circuit blow, another can be easily inserted. This is a serviceable feature, as the house electrician does not have to search and waste time in locating fuses and trouble. From this center of distribution all circuits radiate to the various outlets in the auditorium and stage.

The stage arc lamp pockets are of the most recent type. A three-wire circuit of No. 5 wire is run to the main center of distribution from each pocket and this circuit is protected by a 50-ampere fuse. The incandescent lamp pockets are similar in construction and wiring and are arranged with dimmers on each outside wire, so that one half of the section may be separately dimmed from the other half.

The lighting bridge is a special novelty, and on each side of the stage there are mounted eight, 50-ampere arc lamp pockets, making a total of 16 for both sides, for the purpose of concentrating a powerful illumination upon the stage.

There are five borders, each consisting of 72 white, 60 red, 60 blue and 65 amber incandescent lamps, all of 32 candle-power. There is also a large panorama border of 220 32-cp lamps, arranged in a semicircle. The border lamps are fed from a 48-strand flexible border cable carried in conduit from the main center of distribution to the gridiron, whence the wires drop directly over each border, terminating in a splicing and pull box. Near the end of the pull box, each border cable is securely fastened on the steel border cable by means of a 2½-in. split wire grip laced in the center, so that it is impossible to pull the cable away from the splicing box. Specially designed sheave wheels are also provided for the purpose of having the slack constantly taken up, so that the raising and lowering of the cable will not in any way interfere with the props or scenery. This also guards the cable against mechanical injury. The borders are suspended from four large strain bolt insulators, secured to steel cables running up to the gridiron so that they are perfectly insulated.

The double border strips have wires with slow-burning insulation. The wiring is so arranged that each border is divided in two sections. And consequently one half can be operated from the stage switchboard separately from the other half, in order to get the lighting effect desired.

The foot-lights are made up of four rows of colored lamps, the number of which is approximately the same as in each border.

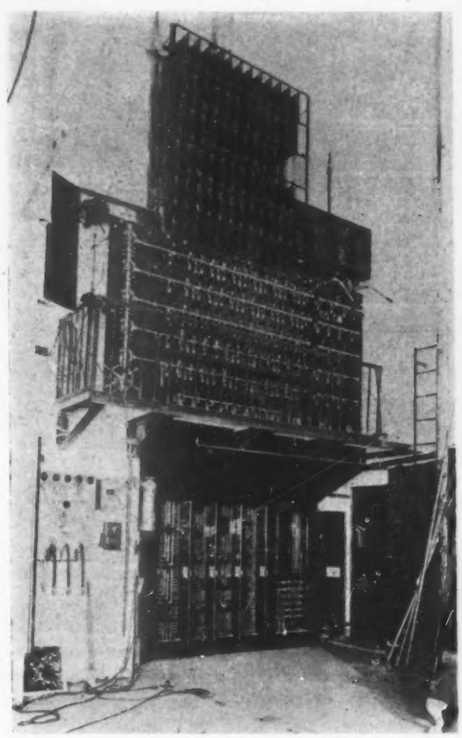


FIG. 2.—STAGE SWITCHBOARD, PANEL BOARD AND DIMMERS.

Instead of the usual galvanized metal gutter, the lamps are wired in conduit with iron boxes, and so arranged that each circuit runs down to the apron of the wiring gutter which is about 32 ft. long and is arranged with sliding covers for the purpose of getting at the different circuits, so that should a wire break through accident, or a short circuit be caused by mechanical injury, repairs can be made in a very short time. All circuits from this wiring gutter built in the apron of the stage terminate in the center of distribution, and the main leads run to the main switchboard through dimmers and are controlled in sections or all together. To the left of the board there is a five-compartment signal cabinet with the wiring so

arranged, that when a push button is pressed underneath each lamp compartment, a lamp will flash at a distant point, and at the same time will indicate on the signal cabinet that the signal has been received, at the stage, each fly gallery, rigging loft, on the opposite side of the stage or in the musicians' pit, as the case might be.

In addition there are speaking tubes and buzzers running to each of the above-mentioned points, should the signal cabinet fail to work. There are also mounted on the signal cabinet 24 buzzers for signals to the occupants of the dressing rooms, and six chimebells distributed throughout the auditorium, lobby, ladies' and gentlemen's retiring rooms, for the purpose of notifying persons there that the curtain is about to rise. The electricity for the bell and telephone system is supplied by a motor-generator situated in the chief electrician's room, where the main meter and distribution board is also located. The latter is a large marbleized slab switchboard with angle-iron frame and enclosed with steel sides and doors, and with a rolling shutter in front. There are five meters, eight motor, and nine three-pole lighting switches mounted thereon. There

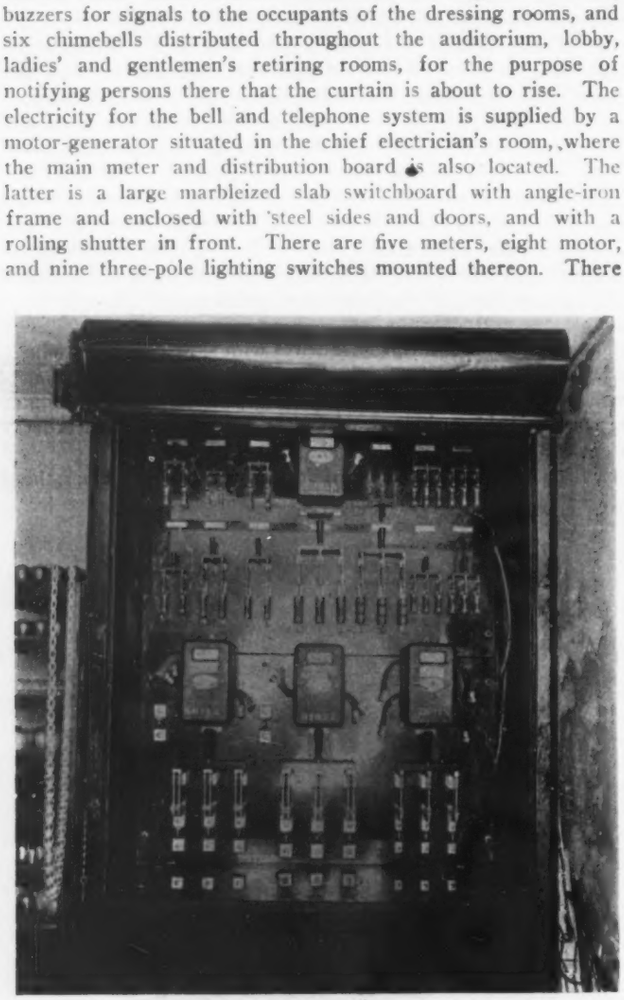


FIG. 3.— MAIN METER AND DISTRIBUTION BOARD.

are two 1500-ampere main feeder switches, for the control of the entire circuits throughout the building, each of which is connected to a separate service from the illuminating company's mains. The 1,500,000-circ. mil feeder leading to the theater board runs in iron conduit underneath the auditorium floor to the main center of distribution behind the stage, where it connects with two sets of busses.

The front-of-house panelboard controls 38 circuits for all exit, stairs, lobby and front-of-house lighting, and this panel is supplied by a separate connection from the Edison company's service.

Perhaps the most novel and pleasing feature of the lighting scheme is found in the auditorium dome. There are approximately 400 incandescent lamps installed behind octagon-shaped Tiffany art glass panels in the ceiling of the auditorium, the light being diffused through these panels, which are decorated with shields bearing coats of arms of famous dramatists, authors and nations which have contributed mostly to dramatic art. Among these is a shield bearing the coat of arms of Stuyvesant, after whom the theater is named.

The other lighting fixtures are for the main part of the concealed type and in no case are the lamps visible in the auditorium. There are eight special column caps of Tiffany glass in the auditorium of antique design which have 36 32-cp lamps concealed in each. All balcony and box lamps are concealed in bowl-shaped fixtures of Tiffany glassware, specially unique and novel in design, imparting to the entire decorations a rich, soft, soothing and harmonious tone.

The theater is also equipped with a Stromberg-Carlson intercommunicating set of telephones wired in iron conduit, with 34-strand special telephone cable, and so arranged that no cross talking is possible under any conditions.

In the basement of the theater is installed a triplex, direct-connected, 25-hp fire pump of the latest type and a switchboard is installed for the automatic control of the motor. The motor is also provided with a hand starter, speed regulator and a pressure regulator which starts the motor as soon as the pressure is below the requirements of the fire department; besides this there is a Gamewell fire alarm system directly connected to the city fire-engine house.

For the heating and ventilating system there are installed an 84-in. blower which forces the hot or cold air to the auditorium, and a large exhaust fan in the dome of the auditorium, for the purpose of ventilating the entire house. The fans are of the Howard & Morse type, and are direct-connected to C. & C. motors of the enclosed type. In the center of the stage is a large electric elevator for lowering all properties to the basement and sub-basement for storage. The elevator is equipped with controlling devices and is provided with a mechanical safety clutch. The total travel is 32 feet.

The electrical equipment was installed by Messrs. Nimis & Nimis, of New York City, and is the first installation in New York City put in under the recent rules for theater wiring framed by the National Board of Fire Underwriters.

Application of Variable Speed Induction Motors to the Making of Matches.

By S. A. Wolff.

A complete Allis-Chalmers power equipment consisting of two 300-kw generators direct-connected to Reliance engines, a 110-kw generator direct-connected to a high-speed engine, a five-panel switchboard, 24 5-hp variable-speed induction motors and a number of constant-speed machines for distribution throughout the plant, was recently sold to the Diamond Match Company for its branch factory at Oshkosh, Wis., all of the apparatus being designed for three-phase, 60-cycle, 440-volt service. The unusual feature of this installation is the fact that the match machines, which have always heretofore been group driven, in this new plant will each be driven by a 5-hp, 1200-r. p. m. Allis-Chalmers induction motor, 24 machines comprising the initial installation. It was shown by careful tests that individual drive in this plant will decrease the required energy at least 1 horse-power per machine by eliminating the use of a mechanical speed changer as well as the long countershafts joining the groups of machines in the older installation.

In the process of forming the matches, 72 sticks are made at each stroke by as many cutters. These sticks are then forced into countersunk holes of a plate conveyor from which they project at right angles, similar to the bristles of a brush. The motion of the conveyor is intermittent, depending on the speed of the machine. The travel being just sufficient to preserve a row of holes for each stroke of the cutters. While the sticks are in position in the conveyor they are in turn dipped in molten paraffin and a composition which forms the head. The matches must be dried before packing and to accomplish this end, the conveyor makes a number of loops exposing the matches to fans.

The test showed that .65 ehp is required to drive the speed changer alone; the machine proper consumes 2.5, 2.7 and 3.4 ehp at speeds corresponding to 160, 194 and 220 strokes of the cutters. Five-hp motors were, therefore, chosen as being of the proper size for the work. It should be explained that speed reduction becomes necessary only during damp weather in order to allow the matches a longer interval in which to dry.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—Commercial reports indicate little change, but there was greater confidence as regards the business situation after Jan. 1. Just now, holiday trade monopolizes attention. In some sections, it exceeds that of last year, although the aggregate sales do not compare favorably with those of the latter period. Jobbing and wholesale lines are seasonably quiet, while manufacturing operations are curtailed pending the resumption of normal demands. Among the industries a feature is the continuance of the better feeling in iron and steel, accompanied by some inquiries for near future wants. Production is, however, being restricted. Building has shown a heavy falling off, and all materials are dull. During the month of November, building activity fell off sharply, the decrease being 39 per cent from October and 32.5 from November, 1906. Railway earnings for the first week of December show a loss of 8.1 per cent, as compared with the same period in 1906. Mercantile collections are more prompt, but money rates continue high and further engagements of gold raise the total movement about $103,000,000. In financial matters, the country is making gradual approaches to the normal. Advices from the country are more satisfactory. Western banks are showing an increased disposition to pay out currency. Some inquiry for mercantile paper is noted on the part of interior banks at leading Western cities, and some money is beginning to return to Chicago. Preliminary foreign trade returns for November are in excess of a year ago, breadstuffs and cotton exports gaining equally. Prices of many commodities show further strengthening from the low points reached at the height of the stringency in November, but the level of prices is now below a year ago. Sentiment in the iron and steel trade, as noted above, is quite favorable. New business in pig iron, however, is very slight, and prices are weaker. The weekly blast furnace output declined 29 per cent in one month. Business in structural material is fair, and additional orders are pending. The production of copper is being still further restricted, but European holders display considerable pressure to sell on a declining market. Prices were marked off about ⅜ cent during the week, and the closing quotations were 13⅛ cents for Lake, 12⅞ cents for electrolytic, and 12⅝ cents for casting stock. Business failures tend to increase slightly in number, the aggregate for the week ending Dec. 12, as reported by *Bradstreet's*, being 284, as against 272 in the week previous and 220 in the corresponding week of last year.

CHOCOLATE FACTORY PLANT.—The various plants of Walter Baker & Company, Ltd., at Dorchester, Mass., devoted to the manufacture of chocolate and cocoa products, are now operated electrically from a central power plant which is especially well suited to show the economies of electrical distribution. A considerable group of buildings is served from the central plant, no one of which requires enough power to make it an easy matter to select a very economical individual power plant equipment, yet as a whole requiring an output large enough to insure a considerable saving in the cost of energy. The mills comprising the Baker group are all large and have until lately been operated by separate steam plants and line shafting. The change over from several individual plants using line shafts to a central power plant transmitting electrical energy was decided upon three years ago, and has only quite recently been fully carried into effect. The new power station of the Walter Baker Company stands on the banks of the Neponset River, from which its ample supply of circulating water is available. The engine room is 60 ft. x 80 ft., while the boiler room has practically the same floor area. The material used in construction is brick on concrete foundations. The plant was designed for an ultimate rating of 2800 horsepower in boilers and 1750 kilowatts in generating apparatus. The principal units in the station are two large Allis-Chalmers vertical cross compound engines, each 22 in. x 48 in. x 48 in. stroke, operated at 120 r. p. m. and direct connected to 750-kw Allis-Chalmers generators. There are in addition two smaller units consisting of 18 in. x 26 in. simple horizontal engines, each direct connected to Allis-Chalmers 125-kw alternators operating at a speed of 177 r. p. m. The electrical generators deliver three-phase alternating current at 600 volts, which is transmitted directly to the mills for lighting and power use. The circuits to different mills have recording meters. Induction motors are used, there being over 100 machines, ranging from 1 to 75 horse-power, installed. These motors are arranged for either individual or group drive. The arrangement for lighting the group of works buildings is quite elaborate. It is done on a two-wire system at 110 volts, the voltage being reduced from the power feeders by transformers at each mill. These feeders are carried to the various mills through a steel bridge from the power plant, first to the Baker mill, then over a bridge across the Neponset River to the Webb mill, then through a subway 200 ft. long under Washington Street to the Pierce mill, and the others of the group.

LA CROSSE DAM FINISHED.—J. G. White & Company have just successfully finished the closing of the new dam for the La Crosse Water Power Company on the Black River, at Hatfield, Wis. This is a concrete structure 50 ft. in height at the center, by 400 ft. long. The first concrete was laid early in August, and it has taken barely four months to place the entire mass of 24,000 yards. There are still under construction the power house, which is located two miles below the dam, and the canal betwen the dam and the power house. The installation will have 16,000 horse-power, ultimate capacity, and will supply La Crosse and Winona with energy over 90 miles of transmission lines. The pressure will be 45,000 volts.

POWER IN WASHINGTON.—Donald Fletcher, of Tacoma, and Manager N. H. Latimer, of the Dexter Horton Bank, of Seattle, have applied to the commissioners of Pierce County for right to construct lines transmitting electric energy along all highways in Pierce County, stating that they are arranging for the erection of a large power plant on Cle Elum River, in Kittitas County, where the government is now constructing a big dam to get water to be used for irrigation purposes. Mr. Fletcher declines to discuss the details of his plans, but it is understood that he has completed the financing of the big project and is ready to begin construction work as soon as the necessary franchises are obtained.

WESTINGHOUSE IN MEXICO.—American interests have captured a contract for the first electrification of a steam railroad in Mexico. The contract, which was obtained by the Westinghouse Electric & Manufacturing Company, was let by the Compania Minera Las Dos Estrellas, a British concern, which operates one of the largest mining properties in the famous El Oro mining territory. A broad-gauge line, now operated by steam and running from the mines to the town of El Oro, will hereafter be worked by means of big electric locomotives. The electric equipment will be built in Pittsburg, while the mechanical part of the engines will be turned out by the Baldwin Locomotive Works.

BAHAMA LIGHTING.—Sir W. Grey-Wilson, Governor of the Bahamas, who has been abroad on a vacation, arrived at New York last week on the White Star liner *Oceanic*. He said that while abroad he had specifications drawn for a new municipal lighting plant for Nassau, and that the contract for the construction would be awarded to an American company. The governor bestowed much praise on American enterprise, and declared that the contract would be let soon in New York City.

ORIENTAL TROLLEYS.—The Bureau of Manufactures, Washington, reports that an American consul in the Orient advises that one of the railroad companies there is considering the project of an electric street railway in one of the cities of the region in question. He suggests that it would be well for American manufacturers of and dealers in street railway material and supplies to communicate with the company referred to.

MARCONI WIRELESS.—The Austro-American Steamship Company, Limited, has recently arranged to equip its fleet with the Marconi wireless telepgraph system, and the first of these to be fitted up is the *Laura*, which arrived lately in New York.

POWER AT SEATTLE.—Superintendent L. B. Youngs, of the Seattle, Wash., city lighting department, is preparing for an extension of the forces at work on the city's power plant at Cedar Lake and River, and expects to deliver electricity in Seattle from the new power house by June. While the state's action in meeting the payment due on the first of the year was in doubt there was grave apprehension that the work might have to be stopped altogether, and although the state is paying only $100,000 of the $200,000 it agreed to put up on Jan. 1, this sum will be sufficient to insure that the enterprise will be carried on without interruption. The additional $100,000 worth of bonds will be paid for on May 1, and the state officials believe that they will be able to pay over the final $200,000 in the $600,000 bond purchase at that date, although the third and last instalment is not due until July 1 next. Mr. Youngs says: "With this money on hand we can rush the construction work on the Cedar River plant. Thirty-five men are at work on the pipe line from the lake to the power house site, and this number will be increased. Work on the transmission line to the city also will be started shortly, and the power house will be ready to receive the machinery by the time it arrives here from the East. We expect to have the power plant complete and the transmsision line ready to carry the electricity to Seattle in June." At present the city electric light and power plant is loaded to the limit, and consequently little extension work is being done by the department in the city, all the energies being bent on the production of more power. At the "peak load" from 5 p. m. to 8:30 p. m. the 3000 horse-power plant now in use is strained to fulfill its obligations. The new plant will give the city 15,000 horse-power. To give outlet for this surplus energy a good deal of extension wire work will be needed in the city, but as most of the connections can be made with feed circuits now existing, the work in the city will be nursed along until the second payment from the state is made in May, when a large force will be engaged in installing distributing circuits in Seattle.

ALLIS-CHALMERS ENGINES.—Operating electric railways with direct current transmitted at 1200 volts pressure is, at the present time, of special interest, owing to the absence of the high-tension wiring and the now familiar sub-stations. A pioneer road to operate its line on this plan, which is said to have proven entirely feasible, is the Indianapolis & Louisville Traction Company. This system is 41 miles long, connecting Seymour, the southern terminus of the Indianapolis, Columbus & Southern Traction Company, with Sellersburg, the northern terminus of the Louisville & Northern Railway & Lighting Company. The power house is located at Scottsburg, being about the center of the route. The feeding pressure at the power station is 1200 volts between the single No. 0000 grooved trolley and the rails. Two Allis-Chalmers engines of the well-known, heavy-duty type, 26 in. x 48 in., operating non-condensing at 120 r. p. m., drive in pairs four 300-kw, 600-volt generators, with armatures mounted commutator to commutator on the engine shaft, the combined e.m.f. being 1200 volts. In addition to operating its cars at this pressure, the company maintains a line from Sellersburg to Louisville, a distance of 14 miles, at 600 volts pressure; consequently cars are now being run successfully over sections of trolley fed with current both at 1200 and 600 volts.

WESTINGHOUSE CONTRACT.—The Westinghouse Electric & Manufacturing Company has taken a contract for the apparatus for the Penn & Franklin Street Railway Company, which will build a road between Pittsburg and the Westinghouse works at East Pittsburg, a short route in competition with the two lines of the Eastern Pittsburg Railways Company, of the Philadelphia Company, which now run there. The contract is worth $150,000. The receivers report a very satisfactory revival of inquiry for electrical goods.

Financial Intelligence.

THE WEEK IN WALL STREET.—Transactions on the stock market were on a reduced scale and renewed bearishness prevailed in connection with speculative sentiment due to high rates for money and resulting liquidation in holdings in both the standard railroad and industrial stocks. The declaration of scrip dividends by the Western Union Telegraph Company and the Atlantic Coast Line Company also had a bad effect. The extreme heaviness of the Gould stocks, including Western Union, was one of the notable features. Both Western Union and Missouri Pacific broke to the lowest figures they have seen in a long time. When the announcement was made on Wednesday that the Western Union would pay the regular quarterly dividend in stock, that security had a feeble rally. All of the traction and electric stocks were weak, and little business was transacted. Lower prices are recorded in most cases, the heaviest declines being in General Electric, which receded 5½ points, closing at 110½; Westinghouse common declined 5 points, closing at 42½. The preferred issue of Westinghouse, on the other hand, made a gain of 4 points, the closing quotation being 70. After a sharp recovery, the curb market, during the latter part of the week, lost fully half of the improvement, there being sharp setbacks in Standard Oil and American Tobacco. Following are the closing quotations of Dec. 17:

NEW YORK.

	Dec. 10	Dec. 17		Dec. 10	Dec. 17
Allis-Chalmers Co.	5⅞	5½	General Electric	112¼	111
Allis-Chalmers Co. pfd..	16⅛	15½	Hudson River Tel.....	—	—
Am. Dist. Tel.....	—	20	Interborough Met. com..	7	6½*
American Locomotive...	35½	34¼	Interborough Met. pfd..	18½	16
Amer. Locomotive pfd..	87	86½	Mackay Cos.	52⅛	50¾
American Tel. & Cable..	—	—	Mackay Cos. pfd.....	58	58
American Tel. & Tel...102		100¼	Marconi Tel.	—	—
Brooklyn Rapid Transit.	38⅝	37¾	Metropolitan St. Ry....	—	21
Electric Boat	—	—	N. Y. & N. J. Tel.....	—	94
Electric Boat pfd.....	—	—	Western Union Tel.....	56	55½
Electric Vehicle	—	—	Westinghouse com.....	43½	40¾
Electric Vehicle pfd....	—	—	Westinghouse pfd.....	—	65

BOSTON.

	Dec. 10	Dec. 17		Dec. 10	Dec. 17
American Tel. & Tel....102¼		101	Mass. Elec. Ry. pfd....	38	37
Cumberland Telephone..	—	—	Mexican Telephone.....	1½	—
Edison Elec. Illum.....205		208	New England Telep....105		—
General Electric	—	—	Western Tel. & Tel.....	4	—
Mass. Elec. Ry.....	9¼*	—	West. Tel. & Tel. pfd...	52	—

PHILADELPHIA.

	Dec. 10	Dec. 17		Dec. 10	Dec. 17
American Railways.....	44	43	Phila. Electric	6½	6¼
Elec. Co. of America...	8¾	8⅞	Phila. Rapid Transit....	16¼	17
Elec. Storage Battery...	32	28	Phila. Traction	82	82⅝
Elec. Stor. Battery pfd..	—	—			

CHICAGO.

	Dec. 10	Dec. 17		Dec. 10	Dec. 17
Chicago City Ry.....150*		150*	National Carbon	—	—
Commonwealth-Edison ..	77	—	National Carbon pfd....	—	—
Chicago Subway	13½	14⅝	Union Traction	—	—
Chicago Tel. Co.....108½		109	Union Traction pfd....	—	—
Metropolitan Elec. com.	13	16½*			

*Asked.

WESTERN UNION FINANCES.—The directors of the Western Union Telegraph Company, following the recommendation of their executive committee, declared the quarterly dividend of 1¼ per cent last week in the form of treasury stock instead of in cash. The statement of earnings for the quarter ended Sept. 30, 1907, and the statement, partly estimated, for the quarter ending Dec. 31, 1907, which were made public at the close of the meeting, reflect a substantial loss caused by the strike of operators. The report of the executive committee discussed the late strike in considerable detail, the loss of business due to it, and the increase in salaries. The report says: "The property of the company is in first class condition throughout the entire country; the present employees are faithful and efficient and with the passing of the financial depression our revenues will rapidly increase. Although it is believed, as indicated, that business will soon resume and earnings become normal, nevertheless, in view of the present depression, it seems the part of conservatism not to pay cash, but to make a dividend of 1¼ per cent, payable in stock." Of the authorized capital of $100,000,000 the company has still $2,630,000 in the treasury unissued, and it is with this that the dividend is to be paid. Each stockholder will receive 1¼ per cent of his present holdings. The following tables show the earnings for the quarter ended Sept. 30 and for the quarter (partly estimated) ending Dec. 31:

Sept. 30.	1907.	Changes.
Net deficiency	$311,493	Inc. $1,972,011
Interest on bonds	433,063	Inc. 100,376
Deficit	$744,556	Inc. $2,072,387
Dividend, 1¼ per cent	1,217,025	Inc. 1
Deficit	$1,961,581	Inc. $2,072,388
Previous surplus	16,884,781	Inc. 36,053
Total surplus	$14,923,200	Dec. $2,036,335

Dec. 31.	1907.	Changes.
Net revenue	$1,000,000	Dec. $616,791
Interest on bonds	433,062	Inc. 100,375
Balance	$566,938	Dec. $717,166
Dividend, 1¼ per cent	1,217,025	Inc. 1
Deficit	$650,087	Inc. $717,167
Previous surplus	14,923,200	Dec. 2,036,335
Total surplus	$14,273,113	Dec. $2,753,502

DIVIDENDS.—Directors of the Duluth Edison Electric Company have declared the regular quarterly dividend of 1½ per cent on the preferred stock, payable Jan. 1. Directors of the Hestonville Passenger Railway Company have declared the regular semi-annual dividends of 2 per cent on the common stock and 3 per cent on the preferred stock, payable Jan. 1. Directors of the United Gas Improvement Company have declared the regular quarterly dividend of 2 per cent, payable Jan. 15. The guaranteed quarterly dividend of 1¾ per cent on the capital stock of the Manhattan Railway Company will be paid Jan. 2. The Westinghouse Air Brake Company has declared a regular quarterly dividend of 2½ per cent, an extra dividend of 2½ per cent and a stock dividend of 25 per cent of the $3,000,000 increase. Directors of the E. W. Bliss Company have declared the regular quarterly dividend of 2 per cent on the preferred stock and 2½ per cent on the common, both payable Jan. 1. Directors of the Otis Elevator Company have declared a regular quarterly dividend of 1½ per cent on the preferred stock, payable Jan. 15.

WESTERN ELECTRIC STOCK.—An offer has lately been made by the American Telephone & Telegraph Company to the minority stockholders of the Western Electric for the purchase of their holdings. The Western Electric is paying out but 8 per cent in dividends, while actually earning several times 8 per cent. It has $15,000,000 stock outstanding, of which $9,012,100, or 60.08 per cent is owned by the American Telephone Company, while $5,987,900 is held by the public and is distributed among some 600 or 800 stockholders, a considerable number of whom are employees of the company. The greater portion of the outside stock is owned in and about Chicago. The proposed plan amounts to an offer on the part of the American Telephone Company to pay for the 59,679 shares of minority stock either by $13,472,775 in cash, of $14,969,750 in 4 per cent convertible bonds. The offer puts a value of 90 on the bonds to be taken from the $50,000,000 now in the treasury as part of the $150,000,000 issue of 4 per cents, of which a syndicate took $100,000,000 some time ago.

ST. LOUIS CONSOLIDATION.—The long-expected lighting consolidation at St. Louis has at last happened. The North American Company, through the Union Electric Light & Power Company, which it controls, has acquired by purchase the Laclede Power Company and the Edison Electric Illuminating Company of St. Louis. In order to acquire the property, the Union Electric Light & Power Company increased its capital stock on Dec. 2 from $10,000,000 to $18,000,000 and its bonded indebtedness from $10,000,000 to $18,000,000. The purchase price has not been made public, but it is officially stated that not nearly all of the proceeds derived from the sale of the new stock and new bonds of the Union Electric Light & Power Company will be used for the acquisition of the new property. With the purchase of these properties, the North American Company is now in control of all the lighting and power companies and the street railway systems of St. Louis.

BALTIMORE LIGHTING DEAL.—Local Baltimore papers call attention to the fact that by disposing of the telephone plant for $300,000, subject to the mortgages on the property, the Consolidated Gas, Electric Light & Power Company gets control of its competitor in the lighting field for a comparatively small outlay of cash. The terms of the lease provided for the Consolidated taking all of the Baltimore Electric common stock, par $50, at $10 a share, the total amount being $2,500,000, and guaranteeing the dividends on the $1,000,000 of 5 per cent preferred stock outstanding, as well as guaranteeing the interest and principal of the $2,500,000 of 5 per cent bonds outstanding. It cost the Consolidated $500,000 to get the Electric Company's stock, and as a result of the telephone deal it gets back $300,000, thus making the net cost of the control of the Baltimore Electric only $200,000.

WESTINGHOUSE PLANS.—A special dispatch from Pittsburg, of Dec. 17, says: "According to intimations given out at the close of the six-hour conference to-day between President George Westinghouse and the receivers of the Westinghouse Electric & Manufacturing Company, Feb. 1 will probably see the discharge of the receivership. Mr. Westinghouse will ask the issuance of $30,000,000 bonds to take up the outstanding convertible bonds, and provide sufficient working capital. By the understanding reached in New York about $7,000,000 of this issue must be taken by the stockholders, and the subscription of that sum was practically assured at to-day's meeting. The plan is understood to provide for placing Mr. Westinghouse at the head of the board of directors for the operation of the plants, while the fiscal affairs of the company will be put in the hands of a committee."

GENERAL ELECTRIC IN DEMAND.—It is noted from Boston that there has been a most substantial investment buying of General Electric stock during the last three months. The list of stockholders has increased 42 per cent since Jan. 1, 1907. At the present time the company has upward of 7700 stockholders, against 5400 at the beginning of the year. Over 1000 have been added in the last four months. At the opening of the year the average holdings per stockholder were 117 shares, against 83 shares on the first of the month. The broadening of its stockholding constituency will naturally be of material assistance to the company in any future financing.

WESTINGHOUSE AIR BRAKE.—The directors of the Westinghouse Air Brake Company have declared the regular quarterly dividend of 2½ per cent, and an extra dividend of 2½ per cent. Acting upon the authority voted them by the stockholders the directors voted to increase the capital stock from $11,000,000 to $14,000,000, out of which increase a stock dividend of 25 per cent was declared. In declaring a stock dividend of 25 per cent, the directors of the Westinghouse Air Brake Company stated that fractional shares will be represented by scrip, upon which no dividends will be made until exchanged for full shares.

KEYSTONE TELEPHONE.—The Keystone Telephone Company of Philadelphia (combined companies) reports for October and four months, compared as follows:

	1907.	1906.		
October gross	$88,558	$80,848	Inc.	$7,710
Expenses and taxes	48,288	44,741	Inc.	3,547
October net	$40,270	$36,107	Inc.	$4,163
Four months gross	349,160	316,491	Inc.	32,669
Expenses and taxes	183,730	178,166	Inc.	5,564
Four months net	$165,430	$138,325	Inc.	$27,105

HUDSON RIVER POWER.—The statement of earnings of the Hudson River Electric Power Company for October shows gross earnings amounted to $119,880.77, while operation cost $57,359.66. Net earnings were $62,521.11. Gross earnings for October, 1906, were $76,774.99 and operating expenses were $52,730.03, giving net earnings of $24,044.96. The increase in net earnings for October this year compared with the net earnings of October, 1906, was no less than 160.02 per cent, probably one of the best records for the whole country.

LONDON UNDERGROUND NOTES.—It was stated at the office of Speyer & Company last week that holders of about $14,000,000 of London Underground Electric five per cent notes, out of a total issue of $16,550,000 notes, had already availed themselves of the firm's offer and had sold their December coupon to Speyer & Company. This is about 85 per cent of the total American issue, and it is understood that approximately the same amount of sterling note holders have already accepted the similar offer of Speyer Brothers in London.

OYSTER BAY LIGHTING.—On the application of the Nassau Light & Power Company, to the Public Service Commission of the Second District, for an authorization of the acquirement of $35,000 capital stock of the Oyster Bay Electric Light & Power Company, an order has been issued by the commission granting the petition. The stock of the Oyster Bay Company was actually purchased by the Nassau Light & Power Company in 1905, without applying as required by law to the commission of gas and electricity.

POTOMAC ANNUAL.—The annual report to Congress of the Potomac Electric Light & Power Company has been received by the House of Representatives. It shows the gross revenues to be $1,010,552.67 and operating expenses $503,620.70. The surplus after operating expenses and fixed charges are deducted is $357,637.54. The value of the company's property Dec. 31, 1906, is fixed at $8,500,000.

NIAGARA LIGHTING.—The Public Service Commission, second district of New York, has ganted a hearing on the petition of the Niagara Falls Lighting Company for authority to issue $100,000 capital stock, and a mortgage for $500,000, and to issue $300,000 bonds under said mortgage; also for permission to construct an electric light, heat and power plant in the city of Niagara Falls.

GENERAL ELECTRIC DEBENTURES.—Application has been made to the New York Stock Exchange to list $13,000,000 5 per cent convertible debenture bonds, due 1917, of the General Electric Company.

GENERAL NEWS

Construction News.

CARBON HILL, ALA.—Plans are being made to extend the transmission lines of the municipal electric lighting plant to the outskirts of the town. H. T. Butler is superintendent.

CLANTON, ALA.—The Clanton Light & Power Company contemplates equipping its power house with new machinery. J. P. Van Derveer is president and general manager.

DADEVILLE, ALA.—The citizens on Dec. 9 voted in favor of the proposition to issue $10,000 in bonds to improve the municipal electric light plant. J. B. Ryiance is mayor.

HUNTSVILLE, ALA.—The Huntsville Railway, Light & Power Company is planning to duplicate its plant now in operation, which will involve an expenditure of about $40,000. The company has recently placed orders for new machinery.

PRESCOTT, ARIZ.—The management of the Shylock mine is contemplating the purchase and installation of steam and electrical machinery for operating the mine.

ARGENTA, ARK.—The managers of the municipal electric lighting plant are contemplating the establishment of a commercial service and furnishing electricity for the street railway system. A. J. Trotier is superintendent.

EUREKA, ARK.—The Citizens' Electric Company contemplates about three miles of line extension the coming year. George Tilles is treasurer and manager.

FORT SMITH, ARK.—The Fort Smith Light & Traction Company submitted a bid to the City Council offering to furnish 250 arc lamps of 2000 cp for $55 per lamp per year. The Board of Public Affairs recommended the acceptance of the contract for 181 lamps.

HOPE, ARK.—Extensive additions and improvements are contemplated to the municipal electric light plant, which include the installation of two boilers, another engine and dynamo, and the construction of a new power house. A new water works system will also be built. Charles M. Richards is superintendent.

LITTLE ROCK, ARK.—The Penitentiary Board is considering the question of making improvements to the electric light plant at the state penitentiary.

MORRILLTON, ARK.—A new boiler, engine and dynamo have been installed in the local electric light plant, which is owned by W. H. Ashley.

AZUSA, CAL.—Plans have been prepared for the new building to be erected by the Home Telephone Company in this place, and it is expected work will soon commence on the construction of the same.

CHICO, CAL.—On November 29 the De Sabla power plant, of the California Gas & Electric Corporation, was damaged by a 24-in. gate valve on one of the pressure mains giving way. The flood caused by the break necessitated shutting down the plant temporarily. Until the damage is repaired energy for Chico and surrounding territory is being supplied from the Centerville and Colgate plants and also from the system of the Northern California Power Company.

GRASS VALLEY, CAL.—The Sultana Mine Company is contemplating installing a large electric plant in connection with its mine.

LAKEPORT, CAL.—The Lupoyoma Development Company has acquired a controlling interest in the Kelseyville National Gas Company and in the Lake County Electric Power Company, by which it has obtained the franchises and the rights held by one company in Lakeport, and the source of power supply owned by the other company in the gas wells in Kelseyville. George P. Lowe, of San Francisco, has made exhaustive tests of the Kelseyville gas and finds that it is not suitable for lighting purposes, nor for domestic uses, but can be used for furnishing power for operating the electrical plant. Orders have been placed for part of the machinery and poles. The principal machinery will be ordered from the East. George P. Lowe, of San Francisco, and B. H. Henderson, of Lakeport, are interested in the project.

LOS ANGELES, CAL.—The Board of Supervisors has granted the city of Los Angeles a franchise for the construction of a transmission line along the Los Angeles aqueduct at points where it crosses the county roads. This franchise was obtained for the purpose of building a line from Castiac to Elizabeth Lake to transmit electricity to be furnished by the Edison Electric Company. The electric energy furnished will be used principally at the Elizabeth Lake tunnel and at Newhall.

MERCED, CAL.—The Merced Falls Gas & Electric Company is contemplating the construction of a new hydro-electric plant. H. H. Adams is general superintendent.

NEEDLES, CAL.—C. F. Shrader, of Los Angeles, has purchased of the County Supervisors a 50-year franchise to construct a gas pipe line and an electric transmission line in this town, for $100.

OCEANSIDE, CAL.—The Oceanside Electric & Gas Company contemplates extending its transmission line to San Luis, Rey Valley, to furnish electricity for pumping for irrigation purposes. The company will furnish from 150 to 200 horse-power. Eugene V. Griffes is secretary and manager.

PASADENA, CAL.—An election will probably be held early next year to vote on the proposition of issuing $200,000 in bonds for an additional municipal and commercial lighting system for the municipal electric light plant. Herman Dyer is city clerk.

READING, CAL.—An official of the Noble Steel Company states that the electric furnaces at Heroult have been started up again for the production of ferrosilicon and that it is expected operations will be continued indefinitely. Production at Heroult has been suspended temporarily owing to the necessity of getting all of the power company's transmission lines in order for the winter season, and now that this has been accomplished the current required at Heroult will again be turned on and continued without interruption. The steel cells for the battery of charcoal furnaces to be installed at the electric smelter are in process of construction. In all, 14 are to be erected. They are to be of the latest design for the extraction of all of the by-products to be obtained by the destructive distillation of wood. The magnitude of the charcoal industry to be created by electric smelting operations on the Pit is foreshadowed in the statement that upward of 30,000 cords of wood will be used in a year.

RIVERSIDE, CAL.—Work will soon commence on the construction of the electric railway which is to connect Riverside and Colton. The road will be about nine miles in length.

SAN FRANCISCO, CAL.—The Northern California Power Company is contemplating the construction of a hydro-electric station having an output of 20,500 horse-power. E. V. D. Johnson is manager.

SAN FRANCISCO, CAL.—The Northern Electric Railway Company has filed a certificate of increase of bonded indebtedness, the proceeds to be used for general development and improvement purposes. The directors of the company are Henry A. Butters, Louis Sloss, P. B. Lilienthal, E. J. de Sabla, W. P. Hammon and David S. Edwards.

SOUTH SAN FRANCISCO, CAL.—W. J. Martin, of the South San Francisco Land & Improvement Company, has been awarded a franchise by the Board of Supervisors to erect a transmission line for the distribution of electricity for lamps and motors in this township.

UKIAH, CAL.—The Eel River Power Company, which has been working on a power line from the Eel River to Ukiah, has suspended operations for the winter, and Ukiah will be unable to get power from that source until next spring.

VENTURA, CAL.—A franchise has been granted to Julian P. Jones and F. M. Packard, of Los Angeles, for the construction of an electric railway covering the territory from this city to the Ortega ranch in the upper Matilija.

AGUILAR, COL.—Messrs. Hawkins & Barnett, of Pueblo, have secured a franchise to erect and operate an electric plant and will immediately commence work on construction of same. The plant will furnish electricity for lamps and motors to several coal mines adjacent to Aguilar. The cost of the plant is estimated at $25,000.

BERTHOUD, COL.—The Northern Colorado Power Company is planning to replace the present direct-curren street lighting system with an alternating-current system. William J. Preston is local manager.

CANON CITY, COL.—The Colorado Heat & Power Company has placed a contract with the Westinghouse Machine Company, of Pittsburg, Pa., for a 1200-hp turbine engine for its power plant, which will supplement other Westinghouse turbines installed some time ago.

DURANGO, COL.—The Standard Light, Power & Water Company is planning to construct a 2000-hp hydro-electric plant next year. M. Harrington is manager.

LAS ANIMAS, COL.—The contract for the construction of the power plant for the U. S. Naval Hospital at (new) Fort Lyon has been awarded to C. L. de Muralt, 114 Liberty Street, New York, N. Y.

LOVELAND, COL.—At a recent meeting of the Chamber of Commerce the question of establishing a municipal electric light plant was considered.

SALIDA, COL.—The Salida Light, Power & Utility Company is contemplating the construction of a hydro-electric plant, a 10,000-ft. water pipe line, and installing a 750-kw unit. F. A. Sparks is superintendent.

LITCHFIELD, CONN.—A new 100-hp boiler has recently been installed in the plant of the Litchfield Light & Power Company. G. H. Jenkins is manager.

MOODUS, CONN.—The Neptune Twine Mills have installed an electric light plant in their lower mill, and it is expected that other mills will follow in their footsteps.

ROCKVILLE, CONN.—The Rockville Gas & Electric Company is extending its lines to Ellington to furnish electricity for lighting purposes.

SUFFIELD, CONN.—The Village Water Company expects to put its

sub-station in operation on Jan. 1, 1908. Electricity for operating the system will be purchased from the Springfield Street Railway Company, and will be transmitted from the power house at Springfield at 11,000 volts. The present power plant will be abandoned.

WAUREGAN, CONN.—The Wauregan Company is contemplating installing a new lighting system in its plant.

WILMINGTON, DEL.—The Board of Water Commissioners on Dec. 9 awarded to the Wilmington City Electric Company a contract for a term of three years as follows: For six arc lamps at the Porter Reservoir, for $64.92 per lamp per year; electricity for incandescent lighting as required at the Sixteenth Street property, including renewal incandescent lamps, at the rate of 4½ cents per kw-hour; electric energy for the operation of motor at the Sixteenth Street property on any one of the following propositions: First, 4 cents per kw-hour up to 25 hours per month of the connected load (this with a 75-hp motor would be 1400 kw-hours), all in excess and up to 2800 kw-hours at 3 cents; all in excess of 2800 kw-hours per month at 2½ cents; or, second, $1 per month per horse-power connected and 1½ cents per kw-hour for all electricity used. The bid of the Wilmington Light, Heat & Power Company was 5 cents per kw-hour.

WASHINGTON, D. C.—Arrangements have been made by the signal corps in the army to obtain an increase in the telephone system at the interior posts. It is proposed to install 2452 instruments at a cost of $112,318.

WASHINGTON, D. C.—Specifications are on file at the office of the ELECTRICAL WORLD, 239 West Thirty-Ninth Street, New York, N. Y., for the equipment for the heating, lighting and power plant for the U. S. capitol and congressional buildings, bids for which will be received at the office of Elliott Woods, superintendent U. S. capitol buildings and grounds, until Jan. 15.

DE LAND, FLA.—The Electric Light & Ice Company is changing its service from 125-cycle, 1150-volt to a 60-cycle, 2300-volt, three-phase system and will establish a day service. E. L. Hon is treasurer and manager.

JACKSONVILLE, FLA.—An additional 1500-kw Allis-Chalmers steam turbine has been purchased for the municipal electric light plant to be delivered May, 1908.

QUINCY, FLA.—J. B. Price, superintendent of the municipal electric light plant, writes that it is proposed to expend about $10,000 in the near future to improve the city plant. A new boiler of 150-hp, one 75-kw, alternating-current, 2300-volt generator and engine will probably be installed.

TALLAHASSEE, FLA.—The Board of Managers of the municipal electric light plant proposes to establish a day service about April 1, 1908. C. H. Ellis is superintendent.

TAMPA, FLA.—The Tampa Electric Company is contemplating making improvements to its electric light system, which will include the installation of new dynamos and other equipment in power house, and laying new track. A 550-hp boiler has recently been installed.

CALDWELL, IDAHO.—The Caldwell Power Company contemplates installing three 100-kw transformers in its plant. R. V. Sebree is secretary.

EMMETT, IDAHO.—The Emmett Power & Water Company is planning to change from steam to water power in the spring. W. A. Marshall is local manager.

CARTERVILLE, ILL.—H. C. Hope, owner of the Carterville electric light plant, writes that he will probably purchase a 100-kw, alternating-current, 1100-volt, 60-cycle generator, belted type, to be installed in the electric plant.

DELAVAN, ILL.—The Royal Light & Power Company is considering the installation of tungsten lamps on its street lighting system. W. H. Few is manager.

HARRISBURG, ILL.—Charles D. Stilwell, manager of the People's Water & Light Company, writes that the company is planning to make substantial enlargements and extensions to its plant the coming year, plans for which are not yet completed.

HARVARD, ILL.—The Harvard Electric Light & Power Company is contemplating the reconstruction of its entire overhead system. C. C. Condon is manager.

LA HARPE, ILL.—The La Harpe Electric Light & Power Company is planning to increase the output of its plant by the installation of two direct-current generators having a rating of 40-kw each. A. L. Blythe is manager.

MEDORA, ILL.—Frank Watson, owner of the Medora electric light plant, writes that he expects to install a storage battery in his plant in the near future.

MEREDOSIA, ILL.—We are informed that C. W. Skinner, owner of the Meredosia electric light plant, expects to install a complete new plant next spring.

PALMYRA, ILL.—A new direct-connected unit has recently been installed in the municipal electric light plant. Earl Gates is superintendent.

QUINCY, ILL.—The stockholders of the St. Louis, Terre Haute & Quincy Traction Company have voted to increase the capital stock of the company from $25,000 to $50,000. The company proposes to construct an electric interurban railway from Quincy, Ill., to Terre Haute, Ind., via Roodhouse, Virden and Taylorville. The following officers were elected: Edward Yates, of Pittsfield, president; H. C. Simon, of Virden, vice-president; F. W. Knollenberg, of Quincy, secretary and treasurer.

SHEFFIELD, ILL.—The Sheffield Electric Light Company contemplates making some improvements to its plant during the year 1908. H. W. Booth is manager.

WINCHESTER, ILL.—The Winchester Electric Light Company is planning to establish a 24-hour service, beginning about July 1, 1908. Harry Gordon is manager.

ANDREWS, IND.—The Andrews Home Light & Power Company recently purchased a dynamo from the Huntington Light & Fuel Company, which will soon be installed in the plant, and will enable the company to meet the increased demand made upon it.

CROWN POINT, IND.—The Crown Point Electric Company is planning to increase the output of its plant by the installation of a 300-kw turbine. F. H. Keeney is manager.

DECATUR, IND.—The directors of the Ft. Wayne & Springfield Traction Company are considering plans for the extension of the line south to Berne, early next year.

DECATUR, IND.—The city is contemplating replacing the present street lighting system with an alternating-current system in the spring. M. J. Mylott is superintendent.

FARMERSBURG, IND.—The Torr Electric Company contemplates installing a larger engine in its plant in the near future. A. D. Torr is manager.

FERDINAND, IND.—The Ferdinand Electric Light Company is contemplating installing a larger battery in its plant the latter part of next year. William R. Sauer is manager.

GARRETT, IND.—Plans are being contemplated for making extensive additions to the municipal electric lighting system, which include the installation of an engine, generator and a new arc lighting system.

RIDGEVILLE, IND.—The Ridgeville Electric Light, Heat, Power & Water Company contemplates the installation of a 30-kw turbine in its plant. S. C. Lay is manager.

SOUTH BEND, IND.—The Indianapolis, Logansport & South Bend Railway Company has been granted a franchise by the County Commissioners to construct and operate an electric railway along Michigan Avenue from the southern border of the county to a point a short distance south of the city, where the railway will enter a private right of way.

TERRE HAUTE, IND.—The syndicate headed by Frank M. Fauvre, a capitalist and coal operator, of Indianapolis, which proposes to erect a large power-house in the coal fields of Vigo County, is securing the right of way and franchises in the towns and cities to place high-tension wires in the streets and alleys thereof. It is stated that energy can be transmitted as electricity by wire from the Indiana coal fields more cheaply than can be shipped to Indianapolis to be used in a plant.

WASHINGTON, IND.—An injunction suit has been filed in the circuit court to prevent the sale of the Washington municipal electric light plant, advertised for December 16. The complaint alleges that a sale cannot be made at this time without sacrificing the city's interests, and that 80 per cent of the voters do not want the sale made. This action will likely delay the receiving of bids for the plant temporarily.

WINONA LAKE, IND.—We are informed that the Winona Electric Light & Water Company is in the market for a 500-kw, turbo-generator set. The machine is wanted immediately.

WELEETKA, I. T.—We are informed that the Weleetka Light & Water Company is planning to install another boiler having the same capacity of the present one, and either an 80,000 gallon tank or standpipe for the city water works, or a second pump for direct pressure. D. F. Campbell is manager.

BELLEVILLE, KAN.—Plans are being considered to substitute oil for fuel for steam purposes in the municipal electric light plant. E. A. Jackson is manager.

KANSAS CITY, KAN.—Application has been made to the City Council for a 30-year electric light franchise. The proposed new company is composed of a number of merchants in the city, who propose to erect a plant and furnish electricity to merchants and private citizens. It does not ask for city lighting. H. F. Wulf, Henry McGrew, Max Holzmark, Thomas Wood and Joseph McGrew are interested in the project.

TOPEKA, KAN.—The Council committee on gas and electric light has adopted a resolution, which will soon be placed before the City Council, directing the Mayor to call a special election to be held in the spring to vote on an issue of $50,000 in bonds, the proceeds of which to be used for extending and remodeling the municipal electric light plant.

COVINGTON, KY.—The City Council has directed that an ordinance providing for the sale of a telephone franchise be drawn up and that the right be advertised for sale. The Fitzsimmons Telephone Company has been seeking a franchise here for some time and there are several others who may decide to bid.

COVINGTON, KY.—President James C. Ernst, of the Union Light, Heat & Power Company, has refused to sign the contract prepared by the city after he had been notified that his bid was accepted. He insists that the bid contemplated that the contract should be renewed annually for five years and that the contract must contain a clause to that effect. The bid specified $65 a year per lamp with a rebate of $10 provided 450

or more lamps are used, and that the contract be renewed for another year.

FLEMINGSBURG, KY.—We are informed that O'Bannon & Son, owners of the electric lighting plant, are contemplating installing a storage battery to provide for a continuous service.

MOREHEAD, KY.—The Reliance Engineering Company has been retained to prepare plans for a municipal electric light plant to cost $10,000.

PADUCAH, KY.—The Southern Electric Railway Company has been granted a franchise in this city. The company already has secured the right of way between Paducah and Mayfield, and terminals in the latter city.

BATON ROUGE, LA.—The City Council on Dec. 3 awarded a contract to Krumbhaar & Aiken, of New Orleans, for the construction of the sewerage pumping station, which will be operated by electricity. The Baton Rouge Electric Company has submitted a proposition to the Council offering to furnish electricity to operate the station at 5 cents per kw-hour, on a ten-year contract. The cost of the station is estimated at $3,200.

FRANKLIN, LA.—The dynamos for the new electric light plant have arrived. The work of remodeling the plant and installing the new machinery is being pushed as rapidly as possible.

HOUMA, LA.—The town is negotiating with the Houma Lighting & Ice Manufacturing Company for the purchase of the plant to be operated by the municipality. The committee appointed to interview the company in regard to the purchase of the plant reported that it was agreed that each side was to appoint an appraiser to place a value on the plant. The Mayor has been authorized to consult with an expert electrician.

LECOMPTE, LA.—The city has accepted the plans of C. Scott Yeager, of Alexandria, La., for the installation of an electric light plant to cost about $10,000. Baldwin Wood, electrical engineer, of New Orleans, has been selected to supervise the construction of the plant.

THIBODEAUX, LA.—The improvement committee is considering a proposition to do away with steam power and substitute gas producer outfits in the municipal electric light plant; changing the present system to alternating-current and installing larger units. A. R. Staunton is superintendent.

VIDALIA, LA.—The citizens are contemplating the installation of a new street lighting system to replace the system now in use. L. A. Larson is manager.

ASHLAND, ME.—C. A. Flint, owner of the Electric Light Company, writes that he is contemplating changing from steam to water power, and expects to build his own power plant, but as yet plans have not been completed.

FRYEBURG, ME.—The Fryeburg Electric Light Company contemplates changing from steam to water power and building one mile of new line. C. E. Harris is secretary and manager.

TURNER, ME.—Aubrey Willard has leased the electric light plant owned by E. L. Staples for one year.

BALTIMORE, MD.—The United Railways & Electric Company will construct a new power house at its plant on Pratt Street, at a cost of $30,000. The Noel Construction Company has the contract.

POCOMOKE CITY, MD.—The Stevenson Electric Light Company will install a 100-hp boiler in its plant next summer. R. P. Stevenson is owner and manager.

PORT DEPOSIT, MD.—The Port Deposit Electric Company contemplates replacing the present street lamps with 40-cp tungsten series lamps. Walter Flint is manager.

DANVERS, MASS.—The 500-hp Shephard engine in the municipal electric light plant was destroyed by an explosion, Dec. 10, causing a loss of about $5,000.

EASTHAMPTON, MASS.—The Water Commissioners are considering the question of installing electric motors at the pumping station, to take the place of the steam equipment now in use.

HYDE PARK, MASS.—The Hyde Park Electric Light Company contemplates replacing its present street lamps with enclosed arc lamps next spring. M. S. Ross is superintendent.

NATICK, MASS.—The State Board of Railroad Commissioners has given its approval to an order adopted by the Natick Board of Selectmen, granting the Boston & Worcester Street Railway Company the privilege to build and operate an electric railway on several streets in Natick.

WINCHENDON, MASS.—The Winchendon Electric Light & Power Company contemplates constructing an auxiliary water power plant. F. W. Nourse is manager.

EATON RAPIDS, MICH.—Extensive additions and improvements are contemplated for the municipal electric light plant, which will include the installation of a 90-kw dynamo, an 80-hp engine and a boiler of 125-hp. W. H. Woodmansee is superintendent.

FENTON, MICH.—The Fenton Electric Light & Power Company is contemplating extending its lines to the town of Linden for the purpose of lighting the town. E. H. Bliss is manager and treasurer.

GRAND HAVEN, MICH.—The city contemplates making extensive improvements to the municipal electric light plant, including the installation of a 220-hp engine and condenser, direct-connected type; a 150-kw, 60-cycle, two-phase, 2300-volt alternator, direct connected; 100 series alternating-current, 6.6-ampere arc lamps; four 35-light transformers and regulators and necessary switchboards. Bids have been received for the above equipment, but contract has not yet been awarded. The cost of the work is estimated at $14,000. F. C. Weber is superintendent.

HOLLAND, MICH.—The city is contemplating adding a 500-kw directed unit to the municipal electric lighting plant. James De Young is manager.

HOBART, MICH.—The citizens are contemplating installing an additional engine and alternator in the municipal electric light plant. O. L. Shore is manager.

HOWARD CITY, MICH.—The Howard City Electric Light & Power Company contemplates making extensive improvements and additions to its plant, which will include the installation of new switchboard, possibly new generators and additional boiler; also rebuilding of its lines. L. W. Greene is owner and manager.

KALAMAZOO, MICH.—The Kalamazoo Home Telephone Company has commenced work on the construction of its underground conduit system in this city.

MOUNT PLEASANT, MICH.—The Harris Electric Company will install a new generator in its plant and change the system from single to three-phase in about six weeks. E. O. Harris is owner and manager.

MUSKEGON HEIGHTS, MICH.—The City Council has contracted with the Muskegon Traction & Light Company to furnish the city with electric light for one year. The city is contemplating the establishment of a municipal electric light plant.

PAW PAW, MICH.—The municipal electric lighting system is being rebuilt and an entire new plant is being installed, which is expected to be completed and in operation by April, 1908. William H. Mason is city clerk.

PETOSKEY, MICH.—J. E. Niles, superintendent of the municipal electric light plant, writes that new boilers will be installed in the lighting plant to take the place of the ones now in use.

PORTLAND, MICH.—The managers of the municipal electric light plant contemplate installing the meter system in public places, and will charge 4, 5 and 6 cents per kw-hour for electric service. F. L. Jenkins is manager.

FAIRBAULT, MINN.—The old Scott mill property, which was recently purchased by a twin city firm, is to be converted into a large electric plant to furnish electricity in Faribault and Northfield, for manufacturing and other purposes. A concrete dam is to be built, which will furnish 400 horse-power.

PIERCE, MO.—A new engine and dynamo are now being installed in the municipal electric light plant. G. W. Solomon is superintendent.

ST. LOUIS, MO.—The Wooley Electric Company, of which Fred Essen, of Clayton, is president, has filed notice of an increase in capital stock from $25,000 to $100,000.

ST. LOUIS, MO.—The residents of Overhead Park, St. Louis County, being unable to secure electricity other wise for residence and street lighting, have formed a stock company for the purpose of installing a plant.

SEDALIA, MO.—The Sedalia Ice, Light & Fuel Company contemplates the installation of a 700-hp water tube boiler in its plant. E. R. Audler is manager.

SHELBINA, MO.—The citizens are contemplating putting a new boiler in the municipal electric lighting plant next year. E. P. Weaver is superintendent.

SMITHVILLE, MO.—Harry Gordon, owner of the Smithville electric light plant, contemplates replacing the present high-speed engine in his plant with a 14 x 36 Corliss engine.

HARVARD, NEB.—Carl Parker has purchased an interest in the electric light plant and has assumed local management.

OMAHA, NEB.—H. E. Babcock and F. Jaeggi are interested in the organization of a company which proposes to develop Loup River for power purposes. The cost of a 40,000 horse-power plant has been estimated at $4,250,000 by George Sturtevant, 279 Dearborn Street, Chicago, Ill.

TEKAMAH, NEB.—The new electric lighting plant is nearing completion and is expected to be in operation early in January.

WEST STEWARTSON, N. H.—The Allen Electric Company is extending its transmission lines to Beecher Falls, Vt., and expects to have the work completed before the first of the year.

ATLANTIC CITY, N. J.—Plans for the placing of the overhead electric lighting wires in the city in underground conduits have been submitted to the City Council by the Atlantic Electric Light & Power Company. The company proposes to remove the wires on the Boardwalk and place the whole system in conduits within two years, laying the conduit under the sidewalks to avoid the necessity of opening newly paved streets. The cost of the work is estimated at $400,000. The Council approved the plan and virtually assured the company a renewal of a ten-year contract to light the city.

NEWARK, N. J.—The Balbach Smelting & Refining Company has commenced work on the construction of a new power house at its plant on the meadows. The building will cost about $8,000.

NEWARK, N. J.—James J. Seymour, Jr., has been engaged as consulting engineer by the building committee of the Board of Freeholders

to investigate conditions at the county jail to determine whether it would be commercially profitable to establish an electric light plant there.

PITMAN, N. J.—Charles W. Denny has secured the contract to build the power house for the Gloucester County Electric Company in this town, at a cost of $6,000.

PRINCETON, N. J.—R. M. Anderson, assistant treasurer Princeton Theological Seminary, writes that it is proposed to install a central heating and lighting plant next year and to have it ready for the opening of the school in September. The contract for the work will be let late this winter or early in the spring. The Richard D. Kimball Company, 6 Beacon Street, Boston, Mass., has prepared the plans and will have charge of the work.

ALBUQUERQUE, N. M.—The Santa Rosa Telephone Company will put in a telephone system here connecting with the Santa Rosa exchange.

ALAMOGORDO, N. M.—M. H. Fisher, owner of the Alamogordo electric light plant, has completed arrangements with D. Burney, who has a ranch one mile west of the town, to furnish electricity to operate a pump in connection with an artesian well. Mr. Fisher is now building a hydro-electric plant in the Fresnal Cañon, which when completed will give him 2200 horse-power to dispose for pumping and other purposes.

AUBURN, N. Y.—Owing to the Auburn Light, Heat & Power Company having submitted a bid larger by $200 this year than last for the illumination of the county buildings, a resolution has been introduced before the Board of Supervisors calling for bids for the installation of gas engines and dynamos for the purpose of lighting the county buildings.

DAVENPORT, IOWA.—The Independent Light & Power Company has decided to increase its capital stock to $1,000,000. The company now has a plant under construction.

FALCONER, N. Y.—E. W. Jordan, owner of the Falconer electric light plant, contemplates the installation of gas engines and furnishing continuous service, and also a direct-current service for power purposes. W. E. Cowden is manager.

HOOSICK FALLS, N. Y.—The Town Board has contracted with the Hoosick Falls Illuminating Company to light the streets and avenues of the village of Hoosick Falls. The contract calls for 14 arc lamps, 6.6 amperes, at $800 per year. Provision is also made for four 32-cp incandescent lamps to cost $80 per year. The company agrees to furnish additional incandescent lamps at $20 each per year, and additional arc lamps for $60 each per year.

KATONAH, N. Y.—The Public Service Commission in the Second District has granted the application of the Katonah Lighting Company to construct an electric light system in the town of Bedford, Westchester County, and to issue $20,000 in capital stock.

LOCKPORT, N. Y.—James C. Horning, of Castile, will construct an electric light and power plant at Lamont to furnish electricity to light Silver Springs, Castile and Gainesville. The cost of the plant is estimated at $40,000, bids for which will probably be called for about April 1. Charles E. Collins, of Philadelphia, Pa., is engineer.

NEW YORK, N. Y.—John H. O'Brien, commissioner of Water Supply, Gas and Electricity, on Dec. 10 awarded contracts for supplying the city with electricity as follows: The Edison Electric Light & Power Company and the New York Edison Company for electric lighting in Manhattan; the Westchester Lighting Company in the Bronx; the Edison Electric Illuminating Company in Brooklyn; the Queens Borough Gas & Electric Company in Queens, and the Richmond Light & Railroad Company in Richmond. The cost of lighting the city this year will amount to between $3,500,000 and $4,000,000. The price for arc lamps will be $100 per lamp per year for 5,000 arc lamps of 450 watts; all lamps over that number, $95. When the city has 7500 of these arc lamps the cost will be $95 each. Incandescent lamps will cost the same as last year—$22.50 each per year. Electricity for public buildings for heat and other purposes will cost from 7½ to 10 cents per kw-hour, and for power purposes 6 cents per kw-hour.

ROCHESTER, N. Y.—The Board of Contract on Dec. 12 awarded the contract for lighting the new convention hall to James McDonnell, for $2,163.

WATERTOWN, N. Y.—The Common Council on Dec. 3 voted to instruct the city attorney to employ an expert to examine the properties and values of the Watertown Light & Power Company and testify for the city at the coming session of the Public Service Commission.

SALISBURY, N. C.—The Salisbury & Spencer Railway Company has contracted with the Southern Power Company, of Charlotte, for three 100-kw transformers, sub-station and motor generator set for operating the street railway system. The company will furnish electricity for city and commercial lighting and power purposes. Work will commence on the construction of the sub-station in about 30 days and will be ready to receive energy from the Southern Power Company in about 90 days. The lines are now erected within four miles of Salisbury. H. W. Frund is manager.

CLEVELAND, OHIO.—Mayor Johnson does not favor the use of several small generating plants, as proposed by the Cuyahoga Heat & Light Company, of which John C. Keyes is president. He says he thinks one large central station will be better and more economical. As the company has yet secured no franchise to do a general business the plans will probably be changed to suit the mayor. The company planned the small stations so that they might be arranged quickly and easily to supply any part of the town that desires the service.

COLUMBUS, OHIO.—The Board of Public Works has granted the Cincinnati Northern Traction Company a lease authorizing it to erect a high-tension transmission line on the canal property passing through the municipalities of Hamilton, Middletown, Franklin and Miamisburg. The company is to pay 6 per cent on a basis of $1,000 per mile on the property occupied.

COLUMBUS, OHIO.—Bids will be received until Dec. 30 by Edward F. McGuire, secretary Board of Public Service, for furnishing and delivering on or before Jan. 15, 1908, at the municipal electric light plant, Dublin Avenue, wire cable to be used in connection with a 1000-kw generator and motor driven exciter.

FREMONT, OHIO.—The Fremont Yaryan Company contemplates the installation of a new engine, generator and boilers in its plant. B. J. Shockley is superintendent.

JEFFERSON, OHIO.—The Jefferson & Warren Telephone Company has increased its capital stock from $80,000 to $100,000.

NEWTON FALLS, OHIO.—The Electric Light & Power Company is contemplating the construction of a new power house and boiler house. J. W. Carr is owner and manager.

TOLEDO, OHIO.—A mortgage for $100,000 in favor of the Commercial Savings & Trust Company has been given by the Citizens' Lighting & Heating Company to secure a bond issue of that amount. The mortgage covers the company's property at Michigan Street and Jefferson Avenue, its tunnels, rights of way and other privileges. The proceeds of the bond issue are to be used in constructing the system proposed by the company.

PORTLAND, ORE.—The contract with the Portland General Electric Company for street lighting will expire Dec. 31, 1908, and the report of the committee on street lighting submitted to Mayor Lane, Dec. 8, advises that some action be taken looking toward the establishment of a municipal electric light plant, to be operated either by water power or by the garbage crematory plant. The estimate of the committee for street lighting for the coming year is $99,875. This is based on an increase of 75 new arc lamps for next year. The city is now paying at the rate of $63.60 per lamp per year.

PANAMA.—Bids will be received until Jan. 6, by Lieut.-Col. H. F. Hodges, U. S. A., purchasing officer, Isthmian Canal Commission, Washington, D. C., for furnishing engine and generator, switchboard, etc., as per circular N. 408.

FRANKLIN, PA.—The Borough Council on Dec. 13 awarded the contract for the additional engine and generator for the municipal electric light plant to the Allis-Chalmers Company for $8,600.

EASTON, PA.—The Common Council on Dec. 6 voted to authorize the city officials to contract with the Westinghouse Electric Company to install a new street lighting system at a cost of $13,000.

PHILADELPHIA, PA.—It is said that the stockholders of the Johnstown Telephone Company will be asked, at the annual meeting to be held Jan. 20, to vote an increase in the capital stock of the company from $600,000 to $1,000,000 for the purpose of making extensive improvements to the system.

PHILADELPHIA, PA.—The Bell Telephone Company, of Philadelphia, has filed with Governor Stuart a notice of change of name to the Bell Telephone Company of Pennsylvania, due to the absorption of the Pennsylvania Telephone Company and the Delaware & Atlantic Telephone Company, and an increase in its capital stock from $30,000,000 to $60,000,000. The new company will operate in Pennsylvania, east of the Alleghany Mountains, and in Delaware, Virginia, New Jersey, Maryland and District of Columbia, and will have its headquarters in Philadelphia.

PITTSBURG, PA.—Plans are being considered by the City Council for utilizing the Allegheny municipal electric light plant for lighting the entire municipality of Greater Pittsburg.

READING, PA.—The supply, janitors and repairs committees of the School Board are considering the question of installing an independent electric light plant in the administration building at Eighth and Washington Streets to furnish electricity to light the two high schools. The estimated cost of the plant is $5,000.

SHARON, PA.—The Mahoning & Shenango Valley Railway & Light Company has rearranged its rates for lighting mercantile houses and residences. The minimum monthly bill to business houses has been reduced from $1.50 to $1.11, less 10 per cent for cash within ten days. Electricity consumed for lighting on an average of one hour and twenty minutes a day or forty hours per month, each lamp, will be charged at the rate of 12 cents per kw-hour, all used in excess of this to be charged at 5.5 cents per kw-hour, with a discount of 10 per cent if paid within ten days. Residences will be rated at 40 per cent of the annual number of lamps connected, and flat irons and cooking outfits are not to be rated in the lighting current. Lamps for display windows will be charged, if desired, at the rate of 40 cents a month for each 16-cp power lamp, the lamps to be turned on at dusk and off at 11 o'clock on week days, with the exception of Saturdays, when they are to be turned off at 11.30. A new sliding scale has been adopted for electricity for motors, depending upon the amount consumed in comparison with the capacity of the motors connected.

PAWTUCKET, R. I.—The directors of the Pawtucket Electric Company on Dec. 10 voted to turn over the management of the company to the Stone & Webster Company, of Boston, Mass. After the meeting it was given out that this was not a change in the controlling interest of the company, nor was it a merger of the company with any other company, but the action was solely a business proposition to increase the earning power of the plant.

SALT LAKE CITY, UTAH.—D. M. Griffiths, of Salt Lake City, has filed an application to appropriate 10 cubic feet of water per second from Stairs Gulch Creek, a branch of Big Cottonwood Creek. The power developed will be used to generate electricity for lighting and power purposes.

ASHLAND, VA.—It is reported that the City Council has accepted the proposition submitted by the Western Union Telephone Company to place its wires in conduits.

DANVILLE, VA.—At a recent meeting of the Common Council a proposition was considered to secure the services of a consulting engineer to look into the question of the erection of a new municipal electric light plant.

PUYALLUP, WASH.—The Morse Manufacturing Company has installed a dynamo in its plant to furnish electricity to light the homes of the employees of the company as well as the residences of the managers and the mills.

PUYALLUP, WASH.—Fuller & Manley, of Tacoma, have been authorized by the City Council to draw up plans and estimates for the cost of a municipal electric light plant. The estimated cost of operating the plant is also to be given.

TACOMA, WASH.—Donald Fletcher has filed a petition with the County Commissioners asking for a franchise to erect transmission lines along the highways and roads of Pierce County for the transmission of electricity from a proposed power plant on the Cle Elum River above Cle Elum Lake. Mr. Fletcher proposes to erect a large power plant to furnish electricity for lighting and power purposes in the counties of Pierce, Kittitas and King.

WALLA WALLA, WASH.—The Washington-Oregon Traction Company has applied to the City Council for a franchise for the privilege to construct its lines through certain streets of the city. The company agrees to begin construction work within four months, providing it negotiates the sale of its bonds.

CHARLESTOWN, W. VA.—The corporation of Charlestown is asking for bids for lighting the town for one year from Feb. 1, 1908. Bids will be received until Jan. 1.

APPLETON, WIS.—The City Council has decided to ask the Railroad Commission to fix the rate for electrical energy for public and private use, and also for gas for fuel and illuminating purposes. The city's contract with the Wisconsin Traction, Light, Heat & Power Company expired Dec. 1. The city is paying $65 per lamp per year for street arc lamps, which is not considered unreasonable, but the rate for commercial of 10 cents per kw-hour is considered too high.

IOLA, WIS.—The planing mill and electric light plant owned by Frogner Brothers & Sons was totally destroyed by fire recently, causing a loss of about $5,000.

LUCK, WIS.—It is reported that Pederson Brothers have placed a contract with the Minneapolis Electric Motor Company, of Minneapolis, Minn., for the complete equipment of an electric lighting plant. A three-phase plant with a rating of 60 kilowatts will be installed.
60 kilowatts.

CLARESHOLM, ALB.—The Town Council is making arrangements to take over the electric lighting plant here owned by the Claresholm Electric Company. Address W. Moffat, mayor.

EDMONTON, ALB.—The site selected for the civic power plant is five miles up the river from this city. Plans and specifications are now being prepared for the buildings and transmission lines. R. R. Keely is city engineer.

FRANK, ALB.—The McLeod Electric Light & Power Company will install the electric plant here formerly in use at McLeod. The Rocky Mountain Cement Company has also made application for a franchise to light the town, but the application has been held over to see what kind of service the McLeod company will give.

McLEOD, ALB.—The electrical machinery being installed by the Black Diamond Coal Mines Company includes the following: two electric generators of 105 and 250 kw respectively, and three boilers of 150 horse-power each. Manager Underwood states the company will spend $300,000 on developing the mines.

NELSON, B. C.—The Canadian Pacific Railroad is making preparations to electrify certain lines around Nelson, and Lorne Campbell is now looking into the matter and states his plant at Bonnington Falls is now capable of generating 20,000 horse-power and with the installation of more units can be increased to 36,000 horse-power. At first it was intended to electrify the line only on the heavier grades, but from information received by Mr. Campbell it appears that the company intends to electrify all its lines in the vicinity of Nelson. It is probable that the trolley system will be adopted.

VANCOUVER, B. C.—The British Columbia Electric Street Railway Company has purchased from the Vancouver owners the charter for the line to run from this city to Blaine, Wash. This will be a portion of the proposed electric line between Vancouver and Seattle. Address R. H. Sperling, general superintendent.

LISTOWEL, ONT.—The Town Council contemplates purchasing the plant of the Listowel Gas & Electric Light Company to be operated by the town. The value of the entire equipment of the plant, which operates 26 street arc lamps, has been placed at $1,276. The Council has decided not to renew the lighting contract, which has expired, and the town will be in darkness for several months.

New Industrial Companies.

THE CHURCHILL ELECTRIC TIME SWITCH COMPANY, of Pueblo, Col., has been incorporated with a capital stock of $250,000 for the purpose of manufacturing an electric time switch which is designed to automatically turn off show-window lamps, sign lamps or an entire lighting system. The incorporators are: E. E. Churchill, secretary, H. H. Churchill and H. P. Voris.

THE INDUSTRIAL POWER COMPANY, of Milwaukee, Wis., has been incorporated with a capital stock of $120,000 for the purpose of manufacturing gas engines and gas producers. The incorporators are: Cyril J. Atkinson, J. H. Zimmerman and E. C. Stern.

THE MONTAGUE CITY ALUMINUM CARBON & BRICK COMPANY, of Turners Falls, Mass., has been incorporated with a capital stock of $150,000 to produce aluminum from the clay beds at Montague City. The officers of the company are: C. P. Wise, president; W. C. Davis, vice-president; W. H. P. Gilmore, secretary and treasurer.

THE THERMO ELECTRIC SIGN COMPANY, of Camden, N. J., has filed articles of incorporation with a capital stock of $105,000. The incorporators are: E. M. Lyons, J. V. A. Kimmey and Charles A. Hunter. The company proposes to manufacture electric signs.

Obituary.

CAPTAIN JOHN H. FITZPATRICK, of Washington, Ga., died in Lancaster, S. C., where he had been for several days with relatives. Captain Fitzpatrick was a member of the firm of T. M. Fitzpatrick & Brother, of Washington, Ga., and had been actively engaged for the past few years in the development of the water power of northeast Georgia, and especially the power at Anthony Shoals, which he and his brother acquired two years ago at a cost of $35,000. Captain Fitzpatrick was for many years and until his death the commander of the John T. Wingfield camp of Confederate veterans. He was 64 years old and is survived by one brother and four sisters.

Legal.

LIABILITY OF COMPANY FOR INJURY TO WORKMAN BY STARTING UP OF MOTOR WHICH HE IS REPAIRING.—A workman in a cement factory, upon noticing that the brush of one of the motors was out of the brush holder and that the holder was dragging on the commutator, and knowing that, in that condition, the motor would soon burn up and destroy valuable machinery, went to the foreman and told him the condition of the motor; but the foreman refused to have the motor stopped to put it in order, on account of the work that was being done by it at that time. The workman then went to the electrician in charge of the electrical department and told him that if he did not go up there and attend to the motor it would be burned out in a few minutes. The electrician examined the motor and then had a talk with the foreman nearby, after which he told the workman to watch the motor for a few minutes and then stop it, and he would see that no one would start the motor or interfere with it until the workman had fixed it. The workman went down into the basement and threw the switch which stopped the motor. He told the person in charge of the switch and starting box to see that the motor was not again started until orders to that effect were given. The workman then returned to the motor and commenced to make the necessary repairs. In doing so he reached in to feel whether the oil plug was tight or not, where it had been leaking, and at the same time some one started the motor, resulting in injury to the workman's hand which necessitated amputation. No evidence was given as to who started the motor, but the switchman claimed that he did not do it. It was held that the workman and electrician were not fellow servants, so as to preclude the workman's right to recovery, and he was awarded a verdict of $7,500. Marquette Cement Manufacturing Company vs. Williams, Supreme Court of Illinois, 82 N. E. Rep. 424.

POWER COMPANY NOT BOUND TO MAINTAIN GUARD WIRES TO ITS HIGH CURRENT WIRES FROM CONTACT WITH WIRES STRUNG HIGHER UP.—A telephone wire broke during a severe snowstorm and hung down into one of the streets of the city of Lancaster, Pa. It came in contact with a wire belonging to a light and power company and the insulation wore off at the point of contact so that the energy of the electric light wire was communicated to the telephone wire, killing a small boy who chanced to walk against it. It was claimed that the power company was guilty of negligence in failing to maintain a screen or guard above its wires to prevent contact with the wires above in an emergency of this sort. There was no testimony to show that the

erection of guards was a reasonable precaution, nor that it was customary nor practicable to maintain them, and it was held that the company could not be charged with negligence by reason of its failure to erect such a screen or guard. While companies using electricity are held to the highest degree of care, it was said by the court that it could not be left to the jury, drawn from the ordinary walks of life, to determine, without evidence, whether the failure by an electric company to guard its wires would constitute negligence. Stark vs. Lancaster Light, Heat & Power Company, Supreme Court of Pennsylvania, 67 Atl. Rep. 909.

Personal.

MR. W. S. HULSE, consulting engineer, has moved his office in New York City to 44 Broad street.

MR. HENRY DOCKER JACKSON, of Boston, Mass., has been retained by the city of Brockton, Mass., to make a report on the conditions existing on the main water supply pipe of the city, with particular reference to electrolysis and methods for overcoming it.

MR. H. F. MILLER.—Mr. H. F. Miller, formerly the Columbus (Ohio) manager of the Bell Telephone Company, has been made vice-president of the company which has purchased the Maryland Telephone Company of Baltimore. It was sold by the Baltimore Electric Company, the stock of which is controlled by the Consolidated Gas & Electric Light and Power Company. The purchase price is given as $300,000. The company will be operated as an independent, with an affiliation with the Bell it is said. No president has been named because the directorate is incomplete. Mr. Miller as vice-president is in charge of the property. He has been in the telephone business for many years. He originally came from the South. He had charge of the Bell interests at Springfield, Ohio, before going to Columbus in 1903. He was there two years, then went to Dayton to take charge of the Independent Company. After a year he returned to Columbus to take up some work for the Citizens' Company. For a year or more he has been gathering data on the independent telephone business of the United States, and especially on the automatic service, such as is used in Columbus, for a large English syndicate. During this work, Mr. Miller has been living in Cranford, N. J.

MR. H. W. CLAPP.—On December 14, Mr. H. W. Clapp was tendered an informal luncheon at the Engineers' Club, by some of his business friends in New York. Mr. Clapp has recently accepted a position in the electrical organization of the Southern Pacific Company and will shortly remove to San Francisco, so that his friends took this occasion to express their regret at his departure from New York and to wish him success in his new field. Among those present were the following: W. J. Clark, manager traction department; T. Beran, manager New York office; J. G. Barry, manager railway department; W. B. Potter, engineer railway department, all of the General Electric Company; A. R. Whaley, general superintendent electric zone, New York Central & Hudson River R. R. Company, and C. L. Bardo, superintendent electric zone; J. S. Doyle, superintendent car equipment Interborough Rapid Transit Company; H. N. Latey and F. R. Slater, of Latey & Slater Company; W. H. Sawyer, engineer Ford, Bacon & Davis; J. R. C. Armstrong, electric engineer New York City Railway; Alexander McIver, superintendent equipment, New York City Railway; W. C. Campbell, assistant superintendent equipment, New York City Railway; F. V. Greene, Westinghouse Air Brake Company; A. H. Sisson, St. Louis Car Company; J. G. Buehler, president and treasurer Columbia Machine Works, New York City; C. S. Hawley, Consolidated Car Heating Company. During the five and a half years he has spent in and about New York Mr. Clapp has been engaged in some of the most important electric railway propositions as special representative of the railway engineering and construction departments of the General Electric Company. Mr. Clapp has given particular attention to the installation and operation of the rolling equipment used in the electrification of the New York Central Railroad and to the cars for the Interborough Rapid Transit Company's system. He also equipped the cars for the West Jersey & Seashore Railroad, which it will be remembered was an installation of peculiar interest, because of the short time in which the contract was executed. Mr. Clapp has had long experience in railway matters. He is a son of F. Boardman Clapp, managing director of the Melbourne (Australia) Tramway and Omnibus Company. Before coming to America Mr. Clapp was for four years superintendent of motive power of the Brisbane Tramway Company, Brisbane, Australia.

Business Notes.

BLAKE SIGNAL COMPANY.—Mr. James Goldmark, 83 Warren Street, New York City, has been appointed local agent for its specialties by the Blake Signal & Manufacturing Company, of 246 Summer Street, Boston.

THE LORD ELECTRIC COMPANY announces that Mr. W. P. Cosper, well known to the railroad trade, has made arrangements to act as its agent in the Atlantic coast states, and will make his headquarters at its office, 213 West Fortieth Street, New York City. Mr. Cosper has had a long and successful acquaintance with the industry, having been associated with the Garton-Daniels Company and later with the Electric Service Supply Company.

Weekly Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED DEC. 10, 1907.

[Conducted by Rosenbaum & Stockbridge, Pat. Attys., 41 Park Row, N. Y.]

873,005. KNIFE SWITCH; H. P. Ball, New York, N. Y. App. filed April 5, 1905. Relates to a method of constructing terminal clips of a knife-blade-switch of metallic stampings, which are compressed or crimped together into a unitary structure.

873,006. RHEOSTAT; H. P. Ball, New York, N. Y. App. filed Dec. 21, 1905. Provides a circuit closing device adapted to be protected against injury from abnormal load conditions or careless handling. The usual no-voltage and overload magnets are disposed co-axially of the pivot of the operating handle.

873,017. TROLLEY WIRE EAR; W. G. Carey, Schenectady, N. Y. App. filed Feb. 21, 1907. The trolley wire has a grooved upper edge which is engaged by a pair of depending jaws pinched thereon by a nut.

873,021. ELECTROTHERAPEUTIC SYRINGE; H. R. Cool, Bradford, Pa. App. filed Aug. 2, 1907. Has a syringe provided with terminal electrodes.

873,036. TRANSFORMER; J. J. Frank, Schenectady, N. Y. App. filed May 1, 1907. Construction of transformer having a magnetic core and a plurality of sets of secondary coils on different portions of said core. Has series connections between each secondary coil of one set and a secondary coil of another set so arranged as to form a non-inductive circuit.

873,053. ELECTRIC CONDENSER; F. S. Koch, Chicago, Ill. App. filed June 29, 1904. A condenser formed of a folded roll of alternate conducting and non-conducting materials. Has a metal core adapted to be folded within said roll to maintain the same in its folded position.

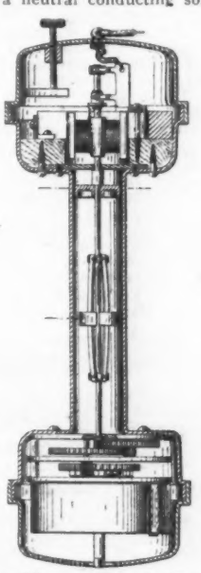
873,061. ELECTRICAL CONTROL APPARATUS FOR STEAM GENERATORS; R. Lomax, et al., Darwin, England. App. filed July 26, 1905. Electrical apparatus for automatically regulating the feed of fuel or the draft in steam generators by means of the rise and fall of steam pressure in the generator, within a predetermined range.

873,064. SYSTEM OF MOTOR CONTROL; W. L. Merrill, Schenectady, N. Y. App. filed April 6, 1907. A system of control for a plurality of electric motors geared to drive devices at widely varying speeds.

873,066. MAGNETO-ELECTRIC DUMB-BELL; James Moore, Manchester, England. App. filed June 12, 1906. A dumb-bell is formed with hollow heads, one containing a spring motor and the other containing a magneto-generator driven by the motor. The circuit of the magneto has its terminals in the handles of the separate bells, they being connected by a conducting cord.

873,072. DYNAMO-ELECTRIC MACHINE; J. E. Noeggerath, Schenectady, N. Y. App. filed Sept. 22, 1905. In a dynamo-electric machine, a motor body comprising two superposed cylindrical members shaped so as to form a chamber intermediate their lengths and provided with holes extending from said chamber to the surfaces of said members.

873,098. METER; E. Schattner, Schenectady, N. Y. App. filed March 24, 1905. A form of meter having an aluminum plate and a plate of carbon placed in a neutral conducting solution. Is made to constitute an integrating ampere meter for alternating currents by connecting two such devices in parallel with each other and in series with the circuit, with the plates oppositely arranged.



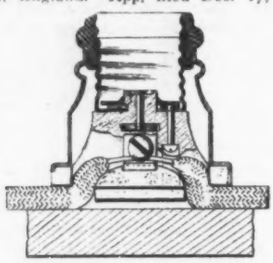
873,066.—Magneto-Electric Dumb-Bell.

873,101. REGENERATIVE SYSTEM FOR BRAKING; W. I. Slichter, Schenectady, N. Y. App. filed June 11, 1906. A diagram of circuits for a controller adapted to operate the motors as a braking generator when descending grades.

873,104. LAMP-RECEPTACLE; James S. Stewart, New York, N. Y. App. filed Aug. 17, 1906. Includes a number of features of a molding receptacle by which it is very adequately protected against grounds and short circuits, and is particularly easy to apply to a molding. The body of the receptacle is made in one piece of porcelain with curved passages for the circuit wires. Beneath the curved passages there are projecting tongues which not only separate the bared portion of the wires from the woodwork, but also accurately position the receptacle on the molding while it is being screwed into place.

873,107. SYSTEM OF DISTRIBUTION; John B. Taylor, Schenectady, N. Y. App. filed Jan. 4, 1906. In a system of distribution, a conductor comprising a plurality of insulated sections, and sources of alternating voltage connected each end of each section and earth and arranged to supply to adjacent sections relatively opposite potentials with respect to earth.

873,132. ELECTRIC ACCUMULATOR; O. Marino and E. W. Barton-Wright, London, England. App. filed Dec. 17, 1906. Construction



873,104.—Lamp Receptacle.

of accumulator in which plates of treated wood are employed to contain the electrolyte and separate the lead electrodes.

873,130. APPARATUS FOR USE IN STARTING AND CONTROLLING ELECTRIC MOTORS; A. Taylor, et al., Manchester, England. App. filed July 23, 1907. A self-contained starter and double-pole switch designed to prevent the current being turned on too abruptly; makes use of a tank of electrolyte co-operating with a removable V-shaped plate as the resistance element.

873,154. TWO MALE T; G. A. Miller, St. Louis, Mo. App. filed Feb. 4, 1907. A form of tee for lightning arresters of the type having a spiral conductor with threaded tips at its extremities where the connections are desired.

873,160. FIELD COIL SUPPORT; E. T. Mug, Norwood, Ohio. App. filed Sept. 30, 1904. Mechanical features of construction of a revolving field for alternating current generator in which the windings are clamped in grooves of the pole faces.

873,166. TRANSFORMER; L. C. Nichols, Norwood, Ohio. App. filed Jan. 15, 1906. A cooling means for transformers of large kilowatt capacity. Has air ducts extending through the cores of the transformer, by which every part is effectively cooled.

873,171. MOTOR CONTROL SYSTEM; W. J. Richards, Norwood, Ohio. App. filed Sept. 29, 1906. Relates to rolling mills and mine-hoisting machinery in which the motors must be frequently and quickly reversed. Has a control system comprising a generator and a motor, the armature of which is exclusively supplied by the generator, said armature being controlled.

873,177. SYSTEM OF MOTOR CONTROL; W. F. Schneider, Norwood, Ohio. App. filed March 25, 1907. Provides means by which the same operations of the main controlling switch produces different results at different times. Is used in train service where different speeds must be observed.

873,178. STATIC ELECTRIC MACHINE; W. C. Shinn, Lincoln, Neb. App. filed Apr. 22, 1907. Complete mechanical construction of Wimshurst static machine.

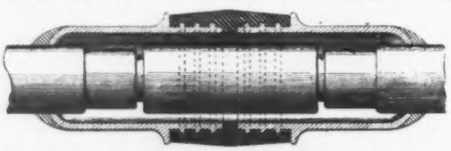
873,215. JOINT FOR METAL-SHEATHED CABLES; C. W. Davis, Edgeworth, Pa. App. filed March 31, 1906. Provides a joint for metal-sheathed cables which will be non-conductive, and at the same time tight, durable, and otherwise serviceable.

873,216. ELECTRIC CABLE; C. W. Davis; Edgeworth, Pa. App. filed Aug. 29, 1906. In order to cool a cable conductor more quickly, patentee has it constructed of hollow form throughout its interior, so that the outside superficial area shall be greater.

873,220. REVERSIBLE GALVANIC BATTERY; T. A. Edison, Llewellyn Park, Orange, N. J. App. filed Nov. 23, 1903. A reversible galvanic battery of the type in which nickel hydroxid is opposed to finely-divided electrolytically active iron in an alkaline solution.

873,253. COIL FOR ELECTRICAL APPARATUS; P. MacGahan, Pittsburg, Pa. App. filed Oct. 18, 1905. A meter coil including a plurality of spiral conductors which are assembled between the end plates so as to form a triple conducting helix.

873,263. ELECTRIC CIRCUIT CONTROLLER; W. A. Paris, Edgewood Park, Pa. App. filed March 3, 1906. Features of construction



873,215.—Joint for Metal-Sheathed Cables.

of a drum controller. Has a pair of solenoids and means for returning the drum to its off position when both solenoids are energized.

873,264. CONTROLLER FOR ELECTRIC MOTORS; W. A. Paris, Edgewood Park, Pa. App. filed April 5, 1907. Relates to modifications of the above.

873,284. CONTROL SYSTEM FOR ELECTRIC MOTORS; L. M. Aspinwall, Wilkinsburg, Pa. App. filed April 4, 1906. Provides means dependent upon a predetermined value of electric current flowing in a motor circuit for retarding the accelerating action; comprises a single-limit switch which may be adjusted to respond to different conditions.

873,290. ELECTRIC APPARATUS; H. L. Beach, Wilkinsburg, Pa. App. filed March 3, 1906. An electric apparatus for producing a step by step movement of an operated device, and automatically returning the aforesaid device to its initial position upon the interruption of a predetermined circuit.

873,298. ELECTRIC MOTOR CONTROL; W. Cooper, Wilkinsburg, Pa. App. filed March 3, 1906. Relates to modifications of No. 873,284.

873,307. ELECTRICAL DROP; G. J. Galbraith, Boston, Mass. App. filed Nov. 19, 1906. Provides an electrical drop in which a trip lever is engaged and released by an armature, so that the armature will always move a fixed distance to engage the trip lever and release it.

873,312. ELECTRICALLY OPERATED COAL HOIST; C. T. Henderson, et al., Pittsburg, Pa. App. filed Jan. 15, 1906. Has a magnetic clutch power transmitting apparatus, whereby power may be transmitted economically from a driving to a driven member.

873,317. ELECTRIC HEATER; M. Landry, Merced, Cal. App. filed March 27, 1907. A rectangular box or casing contains a sinuously arranged resistance conductor.

873,328. PROCESS OF PRODUCING SILICIDS; E. F. Price, Niagara Falls, N. Y. App. filed Nov. 14, 1905. Relates to the production of ferosilicon in an electrical furnace.

873,351. SYSTEM OF CONTROL; F. Darlington, Pittsburg, Pa. App. filed March 3, 1906. Has means by which the movement of one or more electric motors may be caused to correspond in direction and to be accurately proportional in extent to the movements of a master controller.

873,362. LOCK-OUT SWITCH FOR PARTY TELEPHONE LINES; Oscar F. Forsberg, Chicago, Ill. App. filed Oct. 5, 1906. Relates to construction having step by step ratchet operated device.

873,375. GROUND PLATE; B. J. Jones, Cincinnati, Ohio. App. filed Aug. 5, 1907. Has a shell enclosing an inner plate to which the conductor to be grounded is connected. The shell is covered with an absorbent and conducting material.

873,382. STORAGE BATTERY GRID; J. Marx, Buffalo, N. Y. App. filed Jan. 2, 1907. A grid for a storage battery consisting of a framework provided with a series of superposed and horizontally extending bars, and obliquely extending gratings on both sides of said bars.

873,414. ARC LAMP; W. E. Daniels, Chicago, Ill. App. filed July 21, 1906. A lamp adapted for streets and parkways and including an inclosed arc and regulating mechanism all surrounded by a globular shade.

873,415. ARC LAMP; W. E. Daniels, Chicago, Ill. App. filed Dec. 31, 1906. Relates to modifications of the above.

873,419. TROLLEY, AND HARP THEREFOR; S. F. Estell, et al., Los Angeles, Cal. App. filed Aug. 8, 1907. The trolley wheel is connected to its axle by a ball and socket joint so as to be capable of deviating from the normal plane of its rotation.

873,456. WIRE CARRYING CROSS ARM, AND INSULATOR THEREFOR; E. C. Ottinger, Dec'd, Newport, Pa. App. filed April 12, 1906. Patentee makes the telegraph pole cross arms logitudinally divided so as to clamp insulating bushings between them. The bushings are corrugated where they engage the conductor so as to grip it more positively.

873,468. AUTOMATIC BLOCK SIGNALLING SYSTEM FOR ELECTRIC RAILWAYS; P. Townsend, Dec'd, New York, N. Y. App. filed June 29, 1906. A block signalling system for electric railways in which a direct current is impressed upon each block section and utilized to control translating devices governing the action of the signals.

873,503. RECEPTACLE FOR THE DRAIN WATER OF REFRIGERATORS, AND ALARM THEREFOR; A. Casale, New Haven, Conn. App. filed April 17, 1907. A receptacle for drain water of refrigerators includes an alarm device which is actuated when the drain pan attains a certain weight.

873,508. ELECTRO-DEPOSITION OF COPPER AND OTHER METALS; S. O. Cowper-Coles, London, England. App. filed Nov. 12, 1906. Improvements in the electro-deposition of copper or other metals from solutions which have to be maintained in an oxidized state, as for example, the deposition of copper from a cupric solution.

873,522. THIRD RAIL; R. K. Eddowes, Philadelphia, Pa. App. filed Dec. 7, 1906. A third rail having an outer body portion supporting the conducting member face downward and insulated therefrom.

873,587. RAIL MAGNETIC BRAKE; V. L. Ochoa, New York, N. Y. App. filed Feb. 23, 1907. From the frame of the trucks, there depends a rectangular casing having a magnetic winding so as to produce a magnetic pole face adjacent to the track rail.

873,588. PARTY-LINE TELEPHONE SYSTEM; Norman S. Page, New York, N. Y. App. filed Jan. 17, 1907. Complete diagram of circuits.

873,638. BURGLAR ALARM; C. Van Bergh, Winnipeg, Manitoba, Canada. App. filed June 6, 1907. Among other features of a burglar alarm, patentee has a photograph which is stated to "give the alarm," as for instance, by calling "Help," "Police," with the intermittent ringing of an alarm bell.

873,648. MAKING IRON FROM METALLIC SULFIDS; R. H. Aikes, Winthrop Harbor, Ill. App. filed June 1, 1903. A method of making steel of nickel steel from sulfid ores, and incidentally recovering metallic copper or nickel or the alloys of these metals.

873,660. BATTERY CONNECTION; G. P. Blow, La Salle, Ill. App. filed April 11, 1907. A construction of dry battery in which there are no screw connections or binding posts of any sort; makes use of spring plates extended from the electrodes and adapted to establish the circuit connections.

873,662. TROLLEY HEAD; G. P. Copp, Los Angeles, Cal. App. filed March 12, 1906. The trolley wheel is mounted on a specially constructed harp swinging on a vertical axis through an angle of about 45 per cent to either side of the normal running position.

873,668. ELECTRIC TROLLEY; A. S. Janin, New York, N. Y. App. filed Aug. 14, 1905. A trolley of the toggle lever type adapted for electric trains and including a long roller in place of the usual grooved pulley.

873,674. ELECTRICAL TESTING SYSTEM; H. E. Miller, St. Louis, Mo. App. filed April 16, 1906. Electrical testing systems by which an operator may make all the usual tests of electric wiring systems without assistance and avoid certain conditions incident to previous systems which have effected the accuracy of tests.

873,700. ROTATING BRACKET FOR THE SUSPENSION OF ELECTRIC WIRES; C. E. Buckhee, Flushing, Mich. App. filed March 2, 1907. The insulator is supported by a crank arm connection so as to be yielding or flexible: is adapted for use on swinging or unstable supports such as trees, etc.